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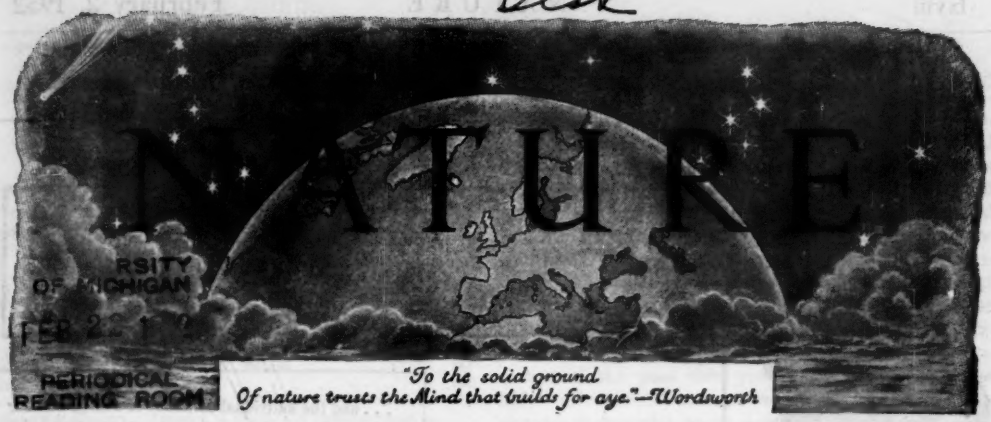

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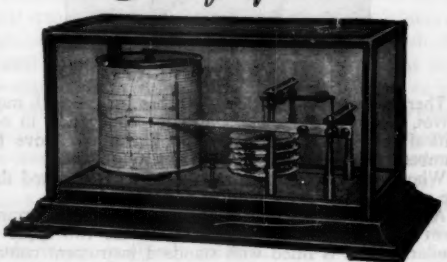

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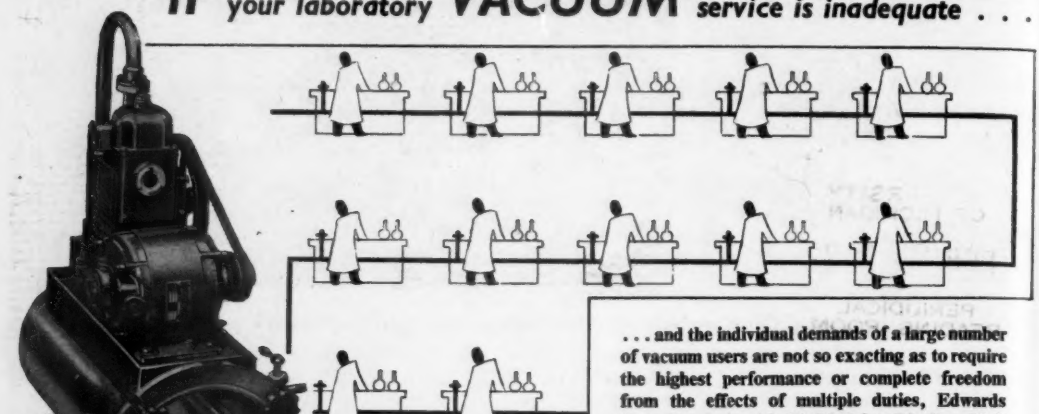

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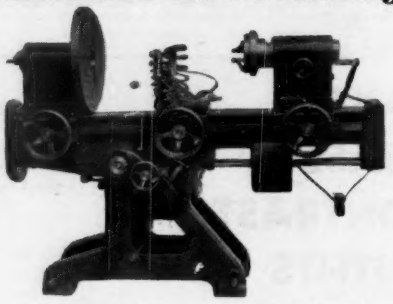

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MAN-POWER PROBLEMS AND EDUCATION

THE five studies of the composition and distribution of Britain's labour force which Political and Economic Planning has published* under the title "Manpower" form the first part of a report on man-power policy and problems which was prepared by PEP during 1946–48 but which was never published. The chapters of that report now reproduced describe in turn the size and distribution of the labour force as it was in 1948, the employment of women, the entry into employment and the education and training of wage earners. The developments of the past two years are discussed in the light of current man-power problems, and each chapter is brought up to date in this way.

While it is admitted that the Census of Population taken in 1951 and the Censuses of Production and Distribution will throw much new light on man-power problems, and that some of the present conclusions may require modification when more comprehensive information thus becomes available, these studies are a valuable contribution to the current discussion on the man-power situation in Britain provoked by the present shortages, particularly of skilled men in the engineering industries, which are hampering the re-armament programme. Already a Cabinet committee is considering whether new measures are necessary to enable important industries to find men and women for the work waiting to be done. It is estimated that by March 1953 between 400,000 and 500,000 more workers will be needed in armament work, and there are already some 36,000 vacancies for skilled men in the engineering industries. About 100,000 of the half-million unfilled vacancies now on the Ministry of Labour's books are in the first preference category—for defence, for exports or for other essential work. Production in the machine-tool and aircraft industries is seriously affected in this way, and the shortage of draughtsmen is more acute than ever. At the same time, the shortage of man-power in the mines and on the railways disturbs the whole economy.

Re-armament has, however, only accentuated the importance of two problems, namely, increasing the total size of the labour-force and recruiting labour for certain key industries, which have been much discussed since the end of the War. The urgent need for increasing production for the export drive, to pay for improved social services, to repair Britain's capital after the ravages of war and the neglect of pre-war years, and to maintain, let alone increase, the consumption which has followed from the re-distribution of income, has also enhanced the importance of these problems; and the question of productivity is closely related. Moreover, although the numerical shortages may not look large against a working population estimated for December 1950 as 23 millions out of a potential 31·8 millions, it must be remembered that, even without the re-armament

* Manpower : a Series of Studies of the Composition and Distribution of Britain's Labour-force. Pp. ix+102. (London : PEP (Political and Economic Planning), 1951.) 15s.

programme, industry would have found it hard to meet requirements. The comparatively small number of boys and girls leaving school each year is not expected to increase until 1957: the P E P study gives the number of new juvenile entrants for 1950 as 465,101.

Other factors also set limits to the total labour force available. The average working-week is now almost as long as it was before the War; but the increase in paid holidays has substantially reduced working-time and in some industries absenteeism has increased. Moreover, as the P E P study points out, the proportion of non-operative staff in manufacturing industry has increased from 16 per cent in 1946 to 16·6 per cent in 1950, and Census of Production figures confirm the increase since pre-war days. In the gas industry, too, non-operative staff has increased since 1939, and P E P, without generalizing on the nationalized industries, comments on the high proportion of non-operative staff in them—in the British Electricity Authority, and in British Railways and Road Transport (in contrast with London Transport).

Reserves from which the labour force can be increased are small. Only about 150,000 of the potential male working population are not in the actual labour force, and P E P estimates that the reserve consists in the main of married women, estimated at 7·35 millions on December 31, 1949. The elderly still provide a possible source of recruitment, but in 1950 about 22 per cent of the male and 6 per cent of the female population of more than retiring age were still in the labour force. Only some 220,000 foreign workers have been admitted by the Ministry of Labour under official schemes since the end of the War, but 137,000 permits have been issued to individual employers for the entry of foreign workers (mostly for domestic service). In spite of this, the number of women in private domestic service in 1950 was only 392,000 as against 465,000 in 1948.

The P E P report adduces some evidence that the regional distribution of industry still affects the recruitment of women to industry, and that redistribution of industry has an important part to play in increasing the female labour force. Material incentives and facilities for women to go out to work have shown little advance, and it is probable that, although in industries such as textiles and clothing improvements in conditions and facilities have played a part, in general women have been 'pushed' rather than attracted into work. P E P concludes that there is still much to be done before the facilities which enable women to take employment, and the conditions which encourage them to do so, are adequate to increase the number of women in employment to the necessary and possible extent, more especially as it will be necessary to rely increasingly on middle-aged or elderly married women not already in employment.

The recruitment of more elderly people, whether men or women, in any event requires a new attitude in industry; and though the number of workers to be obtained is relatively small at present, raising the present age of compulsory retirement seems imperative. Some inquiry, however, is necessary to discover how retired people can be fitted into jobs and what attractions are necessary to retain them in industry. A recent Nuffield inquiry into skill and age suggested that the main decline in old age is in ability to master new operations and new instructions. Providing the work is familiar, old people are often both physically and mentally capable of doing many kinds of work, including heavy manual work and skilled operations. Nor should it be assumed that it is essential to retain a professional or technical worker in the job he would normally have left on retirement. Promotion lines need not be blocked if a little forethought and imagination are exercised, and the experience as well as the skill of the older worker could often be used to help younger workers who have recently entered the same profession or branch of technology.

As regards the recruitment of juveniles, it seems clear from the P E P study that both Government and employers are now trying to improve methods of getting boys and girls into the right jobs, and that in conception the arrangements made by the Youth Employment Service, now being operated by local education authorities and the Ministry of Labour, for placing the younger boys and girls are good, although leaving much to be desired in execution. Co-operation between the schools and the Service has improved in the past two years, and research has been undertaken into the technique of vocational guidance and job analysis. The method of selecting and of training employment officers could be improved, however. The recent report of the Productivity Team on the Training of Operatives (see p. 188) points out that no integrated service for schools such as the Youth Employment Service exists in the United States, and vocational guidance in many secondary schools there is of recent origin and advisory arrangements for juveniles generally are less advanced; but the Team was impressed very favourably by the policy of keeping the administration of vocational training in the hands of practical people and of insisting that instructors in practical subjects should take courses in teaching methods, both before appointment and during their employment. Otherwise the Team considers there is little to be learnt from the organization and administration of vocational schools and institutes in the United States; but it stresses the importance of the much more effective liaison with local industries that is maintained.

The Productivity Team's report contains no specific recommendations for achieving a comparable degree of co-operation between educational establishments and industries in Britain; but it is convinced that development of such co-operation offers a most important contribution to the increase of productivity and the most effective use of resources of man-power. It is an essential factor in the improvement of the education and training of wage-earners at any level, as is testified by reports of other 'productivity teams' which have visited the United States. Such co-operation between industry and educational institutions appears, in fact, to be one outstanding feature

of the American scene; and quite apart from the dependence of productivity upon the level of technical training, such co-operation is an important factor in securing the more efficient use and wiser distribution of existing resources of man-power, at least in the younger age groups.

The connexion between education and industrial efficiency and productivity is made as emphatically in the fifth of these studies by P E P as in the reports of the four Productivity Teams which last year visited the United States to investigate different aspects of education, from the university level to that of training the ordinary operative. On the evidence of these reports alone, no educational 'economy' would be more short-sighted or damaging to the man-power situation and to productivity than lowering the school-leaving age. All the indications, as P E P notes, suggest that industry desires well-educated workers, and the study rightly points out that if industrialists and trade unionists would concentrate their attention on the local technical college and local secondary technical school, and take a deep, continuous and constructive interest in what is going on in the whole of the local educational system, their efforts will be well rewarded. With American industry moving steadily, as the Productivity Team on Training of Operatives notes, towards a position in which all journeymen and apprentices will be high-school graduates and the majority of the other employees will have had high-school education up to the age of seventeen or eighteen, the peril of attempting to secure economy in education in Great Britain by lowering the school-leaving age is obvious. If there is no other means of securing the necessary economies, it may be necessary to raise the age of entry; this would be unpopular and might have repercussions on the recruitment of women workers for industry, but it would not be so disastrous as lowering the age of leaving school might be.

These are considerations which it behoves industry, as well as scientific men and technologists—who rely so largely on the services of well-trained technicians to enable them to make full use of their own ability—to urge on the Government. They must be considered both in regard to the cuts in educational estimates and in relation to means for improving the labour situation. Efficient systems of training for all callings have never been more necessary than they are to-day, in the interests of employers, of workers and of the country as a whole.

The further comments by P E P on vocational education, on training within industry and on continuation schools should be studied in the light of the Productivity Team's report, while there is a concluding section on the training of supervisors which frankly recognizes that much of the progress in this matter since 1938 has been stimulated by observation of what has been achieved in the United States. The figures quoted by P E P indicate that so far only the fringe of the foreman problem is yet being tackled in Britain. If the report of the Productivity Team on Training of Supervisors stimulates a real attack on this problem, an important step will be taken towards increasing both output and the quality of workmanship in industry. Leaving that question on one side, however, P E P concludes in this study that there are three essential tasks of co-operation between industry and educational bodies. First, at the national level, some means is required of avoiding unnecessary duplication and of ensuring that all essential fields are adequately covered, as well as a national policy in staffing technical colleges. At the industrial level, the very sketchy arrangements for keeping the educational system in touch with technical developments in the particular industry should be improved. Thirdly, close and continuous co-operation is required between local education authorities and local industry to ensure that the latter's needs are fully met.

These are long-term measures and designed to secure the more effective deployment and the wiser use of man-power rather than its redistribution. They would help to eliminate waste of man-power and could also encourage the growth of a spirit of co-operation on all sides. That in itself is important and assists the effect of whatever must still be done by economic policy or other direct action to divert labour from occupations where it at present is wasteful or undesirable from the national point of view. While there should be no hesitation on the part of the Government in taking unpopular measures where essential, acceptance of unpopular measures can be facilitated by education and in an atmosphere of co-operation and understanding. Moreover, by using every possible means to improve the immediate efficiency of the labour force, and by raising the age of retirement and providing the conditions which facilitate the employment of women either part-time or whole-time, the strains and difficulties which redistribution involves could well be eased.

One such possibility to which the P E P study directs attention is that of utilizing the period of compulsory Territorial Army service to be undertaken by ex-National Service men to improve their efficiency in industry. These possibilities, to which Sir Harold Hartley also referred in his Will Harvey Memorial Lecture last September, are as yet unexplored. The cumulative effect of a series of such measures might well be considerable, and this particular possibility indicates one direction in which British experience offers something to which American practice offers no parallel. It is in the light of British conditions and British traditions that policy must be conceived and executed.

In the long run, educational policy broadly conceived and executed in co-operation with industry, including the trade unions, will do most to improve the strength of the labour force. Its contribution to increased productivity could ease the situation in important industries already seriously short of labour without the strains that accompany redistribution. Further, it is largely through our educational or training policy that industry can best be imbued with something of the vitality, the readiness to experiment and the freedom from tradition and prejudice which the Productivity Teams have marked as characteristic of American industry. By promoting greater adaptability in the individual worker,

mobility and flexibility in the labour force are also encouraged. These reports and studies leave no doubt that, when every allowance has been made for the differences in background and way of life between the United States and Britain, the real hope of sustained improvement in the British man-power situation lies in the development and improvement of both general and technical education. The school-leaving age must be advanced as rapidly as practicable, for only on the broad basis of educational measures such as are indicated in these reports can we reap the full advantages to be derived from the no less imperative extension of higher technological education itself.

ELECTRON MICROSCOPY: PRECEPTS AND PRACTICE

Practical Electron Microscopy

By Dr. V. E. Cosslett. Pp. xiii+299. (London: Butterworths Scientific Publications, Ltd., 1951.) 35*s*.

IT is not uncommon for major discoveries in science to be anticipated, at any rate to some degree. The discovery of the electron was made by J. J. Thomson in 1897, and from 1899 onwards current-carrying coils were used for 'concentrating' or focusing an electron beam. The major experiments of Busch in 1926 on the lens properties of axially symmetric electric and magnetic fields had, therefore, to some extent been foreshadowed by the early designers of cathode-ray tubes. By 1936 results very roughly comparable in resolving power with those of optical microscopy had been obtained by the further application of the optical properties of electron lenses. The developments of the next few years led to the achievement of much higher resolving power, and to-day 15 A. and less is sometimes claimed; although most instruments, as normally used, are rarely capable of distinguishing objects smaller than about 50 A.

In the electron microscope of to-day, physicists and engineers have applied the principles of electron optics to produce an instrument which is widely used in all branches of science. While these principles are fairly easily understood by most scientific workers with a degree training in physics, the techniques and practice of electron microscopy are complex and, from many points of view, still in their infancy. Dr. V. E. Cosslett, who has done so much in Great Britain to encourage the subject in its own right and to train many young workers, has written a very welcome book on the practice of electron microscopy. Few users of electron microscopes will fail to learn something of value from this book, and many will learn a great deal. It is very easy in the process of studying 'important' specimens to forget some of the physical principles on which an instrument is based, and thereby fail to use the instrument to its best advantage.

In the study of new material, particularly if it be of a biological character, Dr. Cosslett rightly stresses the need for careful investigation of appropriate methods of preparing the specimens. He also emphasizes, with some justification, the danger of using as a standard of reference results obtained in the light microscope with fixed and stained preparations of such material. Phase-contrast photographs of living material may well be a better guide.

Users of electron microscopes are by now becoming a little impatient with those who continually remark that the results have been disappointing. This is often based on a lack of knowledge of real achievements and a misconception of the proper use of the electron microscope in scientific research. Detailed knowledge of virus particles, such as those of vaccinia, influenza, and tobacco mosaic disease, have been obtained by this method; and the electron microscope has given a new approach to the study of crystal structure and the growth-processes of crystals; many of the detailed studies of micromorphology, such as those of muscle fibres and spermatozoa, are real contributions to knowledge of considerable importance. The electron microscope is not an instrument the use of which can usually be expected to give complete answers to complex scientific problems. It is one valuable tool which metallurgists, physicists, biochemists and biologists can use in conjunction with others. The techniques of applying the electron microscope to the vast range of scientific problems for which it has a potential use are in their infancy. Further improvements in instruments are also likely to be made (diffraction microscopy is an example) but will come much more slowly than the first great advances. There is thus a well-marked dichotomy in the development of the subject as a whole: the physics of the instrument, and the technology of its proper application.

"Practical Electron Microscopy" contains eleven chapters, and is to some extent a companion volume to "The Practice of Electron Microscopy" edited by Drummond. Seven of the chapters are essentially concerned with the physics of the instrument, its operational requirements, and the recording of the image. Three of the remaining chapters deal with the very wide range of techniques that may be used in studying a variety of specimens, and with the present limitations and future prospects of electron microscopy. The book closes with a discussion of electrostatic and other types of electron microscope.

The electron microscope may be used in a vast range of scientific problems: the subject of inquiry may be the replica of a metal surface, a minute growing crystal, or a micro-organism; and the literary dangers of confusion are manifest. Dr. Cosslett has avoided these difficulties with great skill. The book has been carefully written in a clear and unambiguous style which will be found most helpful to all who use it. Inevitably there are many aspects of electron microscopy on which the author has not attempted to give more than a brief introduction; p. 202 and Fig. 93, for example, do not adequately convey the information on fine-structure in collagen fibres which has now been known for some years. However, the ample bibliography of nearly three hundred references signposts the reader to much valuable original literature. The subject index is not sufficiently extensive and could with advantage be amplified in the next edition. The recommended use of astigmatism to enhance detail (p. 157) is a somewhat dangerous doctrine. Certain text-figures suffer a little from lack of boldness, particularly noticeable in the lettering, for which a suffix-notation has been freely used. The photographic illustration of a variety of commercially available instruments is perhaps scarcely worth while from a scientific point of view; and surely something has gone wrong with the stereoscopic pair of micrographs reproduced on p. 249? The paper and printing of this volume are good; the modern practice of

reproducing half-tone plates on the same paper as the text is doubtless dictated by economic factors, but it cannot always give the highest quality of reproduction.

These, however, are relatively small matters; Dr. Cosslett is to be warmly commended for his labours in writing this clear and stimulating manual, the lines of which lay down the scientific principles and practice. Between the lines we read of the artistic skill and patience which all good electron microscopists must strive to develop and achieve.

J. T. RANDALL

THE CALIFORNIAN FLORA

A Manual of the Flowering Plants of California

By Willis Linn Jepson. Pp. 1238. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 37*s*. 6*d*. net.

An Illustrated Manual of California Shrubs

By Howard E. McMinn. Pp. xi+663. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 49*s*. net.

W. L. JEPSON'S "Manual of the Flowering Plants of California" was first published in two parts in 1923 and 1925 and has been the standard work on the flora of that region ever since. The present volume has been produced by offset-printing from the original and is therefore identical with it. While in consequence no advantage could be taken in this issue of any additions to our knowledge of the flora of this area during the past quarter of a century, yet, on the other hand, this indispensable and authoritative work first issued at seven and a half dollars is thus made available to students at what is to-day a remarkably low figure, namely, about two-thirds of the original cost.

The text contains descriptions of more than four thousand species and is illustrated by more than a thousand line-drawings. The author, who died in 1946, was one of the leading taxonomists of the United States and the outstanding expert on the Californian vascular plants, so that it is a great boon that this classic flora should thus again have been rendered readily available, the more so having regard to the intrinsic interest of the vegetation of this area both botanically and horticulturally.

More than a third of the native flowering plants of California are endemics and include some that are notable alike for their botanical interest and their beauty. Such are the mariposa lilies (*Calochortus* spp.), with their exquisite flowers and remarkable hairy glands upon the petals, or the monotypic *Carpenteria californica*, with its profusion of stamens, that decks the foothills of the Sierra Nevada.

The second work here under review, that by Prof. H. E. McMinn, is similarly offset-printed and again provides, at a remarkably low price, a handbook to the shrubs of California, this category being widely interpreted to include a total of about a thousand species and varieties. The Californian shrubs include many horticultural favourites such as the flannel bush (*Fremontia californica*), a monotypic tree of short life-span not normally attaining more than twenty-five years, and the fuchsia gooseberry (*Ribes speciosus*).

Among the more characteristic of the shrubby genera of the area may be mentioned *Ceanothus* and *Arctostaphylos*. Of the total species of the former, numbering about forty, no less than two-thirds are native to California, and indeed *Ceanothus thyrsiflorus* is known in British gardens as Californian lilac, while *C. dentatus* and *C. papillosus*, also from the Santa Cruz mountains, are other horticultural favourites. *C. purpureus*, which is represented in a coloured frontispiece, is perhaps the most beautiful of the genus but not hardy in Britain. Of the species of *Arctostaphylos*, numbering about fifty, some forty occur in California, of which perhaps the best known is the endemic manzanita. The seeds of these are said to germinate freely only after a fire has swept over them, though this does not apply to those of the arctic-alpine species. An interesting feature of geographical distribution is the occurrence in California of one species of *Lithocarpus*, whereas all the remaining species, numbering about a hundred, occur in south-east Asia. From California comes the giant *Coreopsis* that attains a height of up to ten feet, although it has a span of life of only about six years. The garryas (*Garrya elliptica* and *G. fremonti*) are both natives of California, although found also in Oregon. Among annuals mention may be made of *Clarkia pulchella* with its three-lobed petals, and the well-known species of *Eschscholtzia* and of *Platystemon californica*.

Both manuals contain very adequate descriptions of, and keys to, all the species treated and are fully illustrated; in the "Manual of Shrubs" these are amplified with more detailed geographical, biological and morphological data. These two works are too well known to need description and treat of a flora that is of wide interest to all who study and cultivate plants. The University of California is to be congratulated on having rendered such useful handbooks again available at so reasonable a price. Their significance as object-lessons in the use of non-conventional methods of printing should not be lost sight of.

E. J. SALISBURY

ABSTRACT ALGEBRA

Lectures in Abstract Algebra

By Prof. Nathan Jacobson. Vol. 1: Basic Concepts. (University Series in Higher Mathematics.) Pp. xii+217. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1951.) 37*s*. 6*d*. net.

ABSTRACT algebra is a difficult subject, which has taken a long time to evolve. Algebra of the ordinary kind has been known for many centuries, but it was not until the nineteenth that Boole showed that there could also be algebras of other kinds. Cayley dealt with matrices and Hamilton with quaternions, for both of which the commutative law of ordinary algebra ceases to hold. The consideration of such systems, suitably generalized, led to the study of abstract linear algebra. But modern abstract algebra owes even more to the unsuccessful efforts to solve an algebraic equation of degree higher than the fourth. Consideration of the underlying reason for this failure led Lagrange, Abel, Galois, Kronecker and others to such fundamental ideas as those of groups and fields. Concepts derived from various sources have been studied in an abstract way in the twentieth century, and great advances have been made, notably by Emmy Noether.

How is the result of this long process of development to be presented to the student? To lead him through the historical route would involve burdening

him with many details which further abstraction has proved to be unnecessary. On the other hand, to start with the position attained at the present time, giving definitions and theorems in their most abstract and concise form, with every trace of their origin removed, may cause great difficulty to the beginner. Prof. N. Jacobson has chosen this second method, though he acknowledges that the beginner may at times find it uncomfortably abstract. The present volume is the first of three, and deals with "Basic Concepts". Volume 2 will bear the title "Linear Algebra" and will deal with vector spaces. Volume 3, "The Theory of Fields and Galois Theory", will be concerned with the algebraic structure of fields.

The introduction to the present volume deals with sets and their mappings, and applies these ideas to the natural numbers regarded as an abstract system. Chapter 1 introduces the idea of a group in an unusual manner, defining it in terms of the much newer idea of a semi-group, although, as the author says, the theory of semi-groups cannot be regarded as having reached a definitive stage. Chapter 2 deals with rings, integral domains, and fields, and Chapter 3 with their extensions. Chapter 4 deals with elementary factorization theory. Chapter 5 resumes the study of groups, now considered in association with operators. Chapter 6 introduces the term 'module' as a composite notion based on those of a ring and a group with operators. Finally, Chapter 7 generalizes some of the previous parts of the theory of groups and rings by a brief treatment of lattices.

The volume contains a good many exercises, of varying degrees of difficulty, and the beginner is advised to study these in order to realize more clearly what is involved in the abstract axiomatic development of the text. H. T. H. Piaggio

GENERAL PHYSIOLOGY

A Textbook of General Physiology

By Dr. Hugh Davson. Pp. xiii+659+16 plates. (London: J. and A. Churchill, Ltd., 1951.) 45*s*. net.

THE teaching of physiology to medical students requires that emphasis be placed on mammalian physiology with the human aspect as the final objective. To this end, numbers of text-books of physiology, of recognized excellence, are available to the student and teacher. Where the needs of the medical curriculum do not prevail, however, and the requirement is for a general approach to physiology, embracing all living material, the degree student is not well provided for. In fact, in recent years no up-to-date British text in general physiology has been available. This lack may put the student of general physiology at a disadvantage, and the need for suitable text-books will be generally admitted.

A desire to fill this gap has stimulated Dr. Hugh Davson to produce a new text-book of general physiology. He sets out his aims in his preface: to meet the needs of the degree student in physiology, botany, and zoology; to help the young research worker; to assist the understanding of physiology by workers in the exact sciences who have not been trained in biology; and to provide information on current activities in general physiology. This is a formidable task. To cover fully the whole field would demand a very large volume, and the production of such a volume at present is apparently economically impracticable. Dr. Davson has met this difficulty by deliberate restriction of the scope of the book, and by economical and direct writing. Even so, the book contains a very large quantity of information, and this is supplemented by a generous bibliography at the end of each chapter.

The book is divided into six sections, as follows: (1) the structural basis of living matter; (2) transformations of energy in living systems; (3) the transport of water and solutes; (4) characteristics of excitable tissue; (5) the mechanism of contraction of muscle; (6) the effect on the organism of light, and biological light emission. Sections (3) and (4) are of comparable length and together make up more than half the total number of pages in the book. Sections (1) and (6) are shorter than (3) and (4), while sections (2) and (5) are approximately one-quarter the extent of the longest sections. The author has deliberately excluded detailed consideration of such subjects as physical chemistry and has very reasonably assumed that the reader has some knowledge of physics and chemistry. He has, however, included some reference to the more complicated techniques which are in use for physiological research.

Despite this arbitrary choice of topics, which the author himself feels is a valid criticism, the book emerges as a well-balanced and representative account of current physiological work and thought. Much vigorous and progressive work is described, and the non-biological reader will be impressed by the very wide range of specialized techniques which are being used in physiological research to-day.

In general, the book is considerably in excess of the needs of the less-advanced student, and the author's hope that it would be capable of keeping the mammalian physiologist in touch with the activities of his general physiologist colleagues is likely to be fully realized.

The type of approach used is perhaps best illustrated by reference to the contents of section (1) of the book, which deals with tissue structure. This is largely concerned with the modern concepts of the cell. The experimental methods for investigation of cell structures are described, ranging from the conventional light microscope, through its ultra-violet and phase-contrast developments, to the principles and use of the electron microscope. Cell structure and mitosis are then dealt with, including the results of high pressures and centrifugal forces on cells. Submicroscopical structure is then considered, with descriptions of polarization microscopy and X-ray diffraction studies as applied to cytoplasmic structure. Finally, nucleoprotein material and the external structures of the cell complete the section. The bibliography for this section gives three hundred titles of papers and monographs, so that the reader need not be in difficulty in the further pursuit of the subject.

The concept of a general physiological approach is fully maintained throughout the book, and the titles of sections in themselves do not, of course, indicate the scope of the work. For example, the section on transport of water and solutes comprises eight chapters, ranging from simple equilibria to kidney function, gastric secretion and bioelectric potentials, among many other topics. The illustrations throughout are numerous and of good quality.

In its aims and in its approach to physiology, this book has a distinct individuality, and there is every reason to expect that it will be warmly received as a worthy addition to British physiological literature.

Substances naturelles de synthèse

Préparations et méthodes de laboratoire. Vols. 1 and 2. Par J. Mathieu, P. Poirier, A. Petit et Dr. L. Velluz. Collection publiée sous la direction de Dr. Léon Velluz. Vol. 1: pp. vii+142; 1200 francs. Vol. 2: pp. vii+138; 1250 francs. (Paris: Masson et Cie., 1951.)

THESE small volumes are the first of a series which is mainly concerned with the laboratory preparation of organic compounds of biological importance. In addition to the preparative details taken from the literature, there is an introductory discussion in each case and a series of notes directing attention to alternative syntheses, and, frequently in an elementary way, to the general use of some of the reactions employed and even to theoretical aspects of the subject. The liberal use of graphic formulæ makes it very easy to follow the synthetical reactions, and there are many references to the literature. In choosing between alternative syntheses the authors have been guided by the practicability of the processes, taking into account the starting materials, the number of steps, yields, etc., and the reasons for the choice are frequently given. Vol. 1 describes the synthesis of ascorbic acid, adenine, adenine labelled isotopically, adenosine, chloromycetin, esculoside, *dl*-histidine, and *l*-tryptophan; Vol. 2 contains adenylic acid, *dl*-aspartic acid, deoxycorticosterone, *dl*-lysine, *dl*-methionine, progesterone, *l*-threonine and *l*-thyroxine.

As distinct from the preparations, each volume contains sections headed "Méthodes" and "Notes pratiques". Under "Méthodes" are reviewed cyclizations leading to coumarins and pyrimidines, the Oppenauer reaction, and the separation of carbonyl compounds. These articles and the practical notes on pure solvents, reactions of carbonyl compounds, and the isolation of ketones, scarcely find a natural place in these volumes.

These books should be of value to those who are not in a position to obtain supplies of the substances described, and who have not the specialized knowledge to choose between the variety of processes in the literature.

W. BAKER

Die Sonnenkorona

1: Beobachtungen der Korona 1939–1949. Von Prof. M. Waldmeier. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, Astronomisch-Geophysikalische Reihe, Band 4.) Pp. 270. (Basel: Verlag Birkhäuser, 1951.) 28.60 Swiss francs.

THIS, the first of three volumes which are to deal with the solar corona, is primarily a summary of 1,400 observations made with a Lyot-type coronagraph at the Arosa Astrophysical Observatory, a mountain station of the Zurich Observatory, situated at 2,050 metres above sea-level. The results are given in polar diagrams, showing the brightness of the low corona in the light of the green emission line λ 5303 A., at a height about 30,000 km. above the limb, or in the red line λ 6374 A., at a height about 20,000 km. The diagrams are clear, concise and well reproduced, although it is unfortunate that superficially they bear a misleading resemblance to isophotes in the corona.

The observations extend over about eleven years, and cover the whole range of variation to be expected during the sunspot cycle. They furnish an excellent example of how very valuable astronomical results may still be obtained with comparatively simple apparatus, provided the astronomer knows what needs doing, and has the necessary drive and persistence. There is a short introduction to the book, describing the Observatory, the instrument, and the technique of observation.

The two succeeding volumes, also by Prof. Waldmeier, are to be devoted respectively to a full discussion of these and other observations, and to a comprehensive monograph on the corona. Together they seem likely to take their place as a standard reference work, in a subject which has assumed great importance during recent years, in radio physics as well as astronomy.

Hugh Robert Mill

An Autobiography. Pp. xii+224+6 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 18*s*. net.

WHEN in 1945 Dr. Hugh Robert Mill wrote his autobiography, the University of Cincinnati reproduced one hundred copies for personal distribution under the title "Life Interests of a Geographer, 1861–1944". By chance one of these duplicated copies came into the hands of Prof. Dudley Stamp, who was "so enthralled by this simple moving story of a long life's work, and entranced by the thumb-nail sketches of great personalities" that he arranged for its publication.

Mill's father was a country doctor practising in Caithness, but his family connexions included John Stuart Mill and W. E. Gladstone. Words were in his blood, and no inconsiderable part of his genius lay in his powers of exposition. A chapter of his autobiography describing his adventures in authorship bears the title "The Use of Words"; but this was a general interest, enlivening all the "twisted strands" of a career embracing chemistry, oceanography, geography and meteorology, including the study of rainfall.

This autobiography throws light on the development of the scientific treatment of geography and portrays Mills's personal contacts with the leading geographers, polar explorers, meteorologists and water engineers, both in Great Britain and abroad.

The Sea and its Mysteries

By John S. Colman. Pp. 285+17 plates. (London: G. Bell and Sons, Ltd., 1950.) 12*s*. 6*d*. net.

MR. JOHN COLMAN, who is now director of the Marine Biological Station at Port Erin, Isle of Man, is well suited to write a book on the sea, for he has considerable experience not only of marine biological work from a shore station, but also of the methods of oceanographic research from a ship on long cruises. The first four chapters of his book, which cover the physical and chemical hydrography of the sea, give a very readable account of the more difficult aspects of oceanography and incorporate much recent work on the importance to the animals and plants of the minor trace elements. In the chapter on coral reefs he has given one of the best recent accounts of this controversial subject, and has illustrated his argument with simple line-drawings, largely based on the work of the Great Barrier Reef Expedition. The chapters on the animal plankton and life between tide-marks are necessarily short, but they are well designed to whet the appetite for further reading of the works mentioned in the bibliography at the end of the book. This book is a welcome and well-written addition to the literature on the science of the sea.

THE DIFFUSION CLOUD CHAMBER

By A. J. BARNARD and J. R. ATKINSON
Natural Philosophy Dept., University of Glasgow

THE cloud track chamber, originally designed in 1911 by C. T. R. Wilson, has been, for forty years, a most powerful research tool in experimental physics. In the early investigations of the properties of ionizing particles and radiations from radioactive bodies, in the work upon atomic disintegrations, in the discovery of the neutron, of the positive electron and, more recently, of mesons, the Wilson cloud chamber has played a most important part. Although many changes have been made in technique and accessories, the mode of operation of the cloud chamber has remained fundamentally the same as that of Wilson's original chamber, in which a sudden expansion of a saturated gas gives rise to a supersaturation which lasts for a very short time-interval normally of the order of one-fiftieth of a second. Techniques have been developed which enable expansions to take place every ten seconds; but the idea of chambers with a permanent supersaturation has always been attractive, since this should allow a considerable increase in recording rate. The diffusion chamber seems the most likely type to meet this requirement, but until 1939 no real progress had been made in the development of such a chamber. In that year Langsdorf[1] constructed an experimental chamber which met with limited success. For various reasons, interest in this type of chamber has recently been revived, and chambers of various designs have been described by Cowan[2], Miller, Fowler and Shutt[3] and Needles and Nielsen[4].

In diffusion cloud chambers, the supersaturation is achieved by the diffusion of a vapour from a hot to a cold surface through an inert gas. Under certain conditions, the supersaturation in a region near the bottom of the chamber becomes high enough for condensation to take place on ions. Since the vapour supply is constantly replenished by diffusion from the roof, the chamber becomes almost continuously sensitive to ion tracks. The diffusion chamber is normally simpler in design than the expansion type of cloud chamber by virtue of the lack of any moving parts, valves and resetting mechanisms.

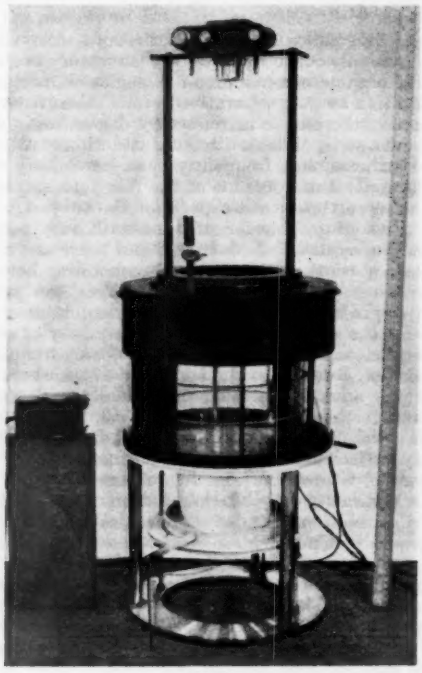

Fig. 2

As a result of early experiments of this nature, there seems, however, to be good reason for doubting the ability of such chambers to deal with a continuous high level of ionization, and the primary objective of continuous recording of tracks may not be achievable. However, for use with pulsed ionizing sources such as synchrotrons, great advantages might be gained by the absence of moving mechanical parts and timing complications. As a tool for the study of the phenomena of condensation, the chamber also offers many interesting and new possibilities.

For these reasons, an experimental chamber has been constructed at Glasgow and is illustrated diagrammatically in Fig. 1. This chamber is similar to one of the chambers described by Cowan[2] and has proved very successful and straightforward to operate. The purpose of this article is to report upon the behaviour of this chamber and to describe the conditions under which good tracks have been obtained. It is too soon to attempt a quantitative explanation of many of the phenomena which have been observed, but it is felt that a qualitative account of the basic features of operation might be of value to other experimenters who are engaged in similar design work elsewhere.

The bottom of the chamber is a $\frac{1}{4}$-in. thick brass plate blackened with stove polish.

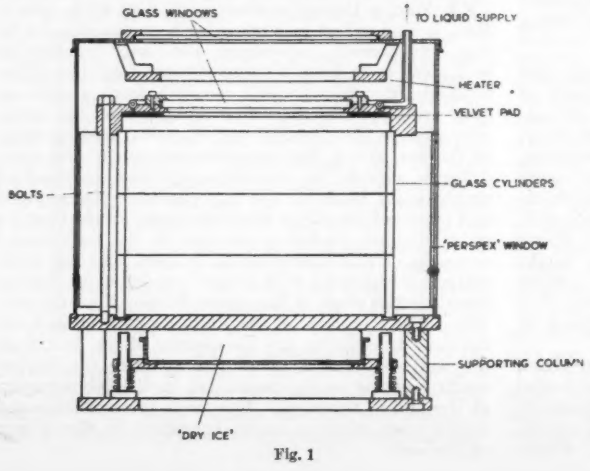

Fig. 1

Fig. 3

Fig. 4

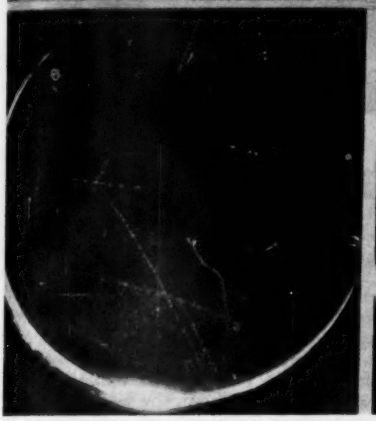

Fig. 5

Fig. 6

When this surface becomes covered with liquid, it forms an excellent background for photography. The walls of the chamber are formed by three glass cylinders, each nine inches in diameter and two inches high; lead wire (20 gauge) serves as an adequate gasket between the cylinders. The brass top of the chamber has a window for viewing and for photography, and is clamped to the glass cylinders by means of six pillars. The top plate is electrically insulated from the pillars, so that an electric field can be applied between the top and the bottom of the chamber. A ring consisting of sheets of filter paper covered with velvet and fixed to the underside of the brass top serves as a source of vapour. The liquid in use can be fed to this ring through a number of small holes in an annular tube soldered into the top of the chamber. Excess liquid on the bottom of the chamber can be drained off through a small tube leading to the side of the bottom plate.

The bottom of the chamber is cooled by a block of 'dry ice' which is pressed firmly against it by a circular pan supported on three springs. In order to shield the chamber from draughts, it is surrounded by a brass cylinder with 'Perspex' windows. A brass cover with a large glass window completes the shield. The heater coil is suspended from this cover, about half an inch above the chamber top, which is thus heated with sufficient uniformity. Methyl alcohol diffusing through air at atmospheric pressure was first tried and proved to be very satisfactory. A photograph of the chamber is shown in Fig. 2.

About ten minutes after the heater has been switched on and the 'dry ice' put into position, a dense cloud can be seen very near the bottom of the chamber due to condensation on dust particles. The density of drops gradually decreases as the dust is removed. However, as the temperature gradient increases, the region in which drops are formed extends progressively farther up the chamber. The drops frequently tend to form along well-defined lines and fall out in streaks which show very little horizontal movement. After this preliminary period of dust removal, and as the bottom plate cools further, drops are again formed near the floor, this time as a result of condensation on ions. In about one hour the chamber attains a steady working condition with a sensitive volume, near the bottom, about two inches in thickness, that is, one-third of the total depth.

Under these conditions, tracks originating from cosmic rays or radioactive contamination may be seen to form continuously in the sensitive volume, and to fall out under the action of gravity. However, these tracks are rather faint, and, furthermore, are somewhat obscured by a uniform cloud of 'background' drops. It should be noted that in the absence of an electric field the continuous cosmic-ray ionization builds up the ionic density to an equilibrium value (of the order of thousands of ions per c.c.), which is reached when further ionic production is balanced by the removal of ions by recombination. The 'background' drops referred to above are due to condensation upon such ions as diffuse into the sensitive volume from the insensitive upper region, where a large ionic density exists due to this equilibrium state. These drops grow in falling through the sensitive region and thus reduce the supersaturation and impair the quality of tracks formed in this region.

In order to reduce the background density and improve the quality of the tracks, the number of ions diffusing into the sensitive volume must clearly be reduced. The obvious way of achieving this is by the use of an electric field between the top and bottom of the chamber in the way described below. In this connexion it must be remembered, however, that in accordance with normal expansion chamber practice, the *sharpness* of the tracks is

normally improved by working with zero electric field.

When such a clearing field (20 volts/cm.) is switched on, all the ions of one sign which have accumulated in the top part of the chamber are immediately pulled down into the sensitive volume, and a dense cloud results. In falling out, the growth of these cloud drops reduces the supersaturation so completely that the region becomes quite clear and insensitive to tracks for several seconds. After a short interval the supersaturation recovers, and ionizing rays passing afterwards in the sensitive volume produce quite distinct tracks. Unfortunately, however, under these conditions diffuse tracks also begin to appear, due to the action of the field in drawing trails of ion tracks from the upper region down into the sensitive region of the chamber (Fig. 3).

The solution of this difficulty is found by switching off the electric field shortly after the recovery of the supersaturation referred to above. Immediately following this removal of the electric field, the general ion density in the insensitive region is small and there is little consequent general ionic diffusion into the working space. Furthermore, the absence of the field obviates the formation of diffuse tracks in the sensitive region, which would otherwise result from trails of ions formed by ionizing particles in the insensitive region. With ordinary cosmic-ray intensities, the reversion to ionic equilibrium between the processes of ionization and recombination involves a time-lag of several minutes. Hence, for a period of a few minutes after switching off the field, the chamber will be in the best working condition. We have normally delayed the photography and the injection of ionizing radiations for a few seconds after removal of the electric field to enable any diffuse tracks which had previously been carried by the field into the sensitive region to fall away. The photographs shown in Figs. 4 to 8 were all taken during the interval of one minute following this slight delay.

Fig. 8

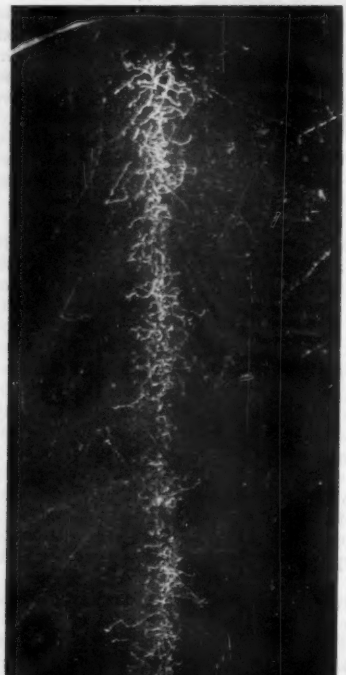

Fig. 7

Figs. 4, 5 and 6 show the electron tracks produced by cosmic rays and contamination. On these photographs diffuse as well as sharp tracks are observed. These are older tracks due to contamination and cosmic rays, which were formed in the sensitive region prior to the photography and must be regarded as an unavoidable accompaniment in the use of a continuously sensitive chamber. As a test of the ability of the chamber to deal with short bursts of ionization of high intensity, a narrow beam of X-rays (energy 40 kV.) was allowed to pass through the sensitive region during a period of about 0·1 sec. (Fig. 7). Fig. 8 shows the result of irradiating the chamber with the whole output of a single pulse of a 30-MeV. synchrotron; this represents about 10^7 quanta of energy greater than 4 MeV. in a cone of half-angle 10°.

The chamber is very sensitive to changes in floor temperature, and the block of 'dry ice' must press firmly against the bottom plate. The temperature of the roof is not so critical; but if it is too high, the ion tracks are no longer sharp while the background drops are much bigger, being formed at a higher level. A roof temperature of about 60° C. was found to be most satisfactory, in agreement with Cowan[2].

The above results confirm that, although only in its initial stage of development, the diffusion chamber may be adapted to permit satisfactory track photography, and that it may possess definite advantages over the normal expansion chamber for certain applications.

The arrangements for recording the photographs have followed usual expansion-chamber practice. The photography has been carried out at a lens aperture *f*.8 using Kodak *R*55 35-mm. film. Two krypton lamps provided the illuminating flash, each

being run at about 250 joules. The lamps were triggered by the secondary of a motor-car ignition coil the primary of which was excited by the discharge of a 4-μfd., 300-V. condenser.

We gratefully acknowledge the work of Mr. McCall, Mr. Irvine and Mr. McLean, in connexion with the construction of the chamber, and Mr. Inglis and Mr. Paxton, for assistance in building the ancillary equipment and in the photography. To Prof. P. I. Dee, Prof. E. W. Titterton and Dr. G. A. Wyllie we are greatly indebted for helpful discussions, information and encouragement.

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[2] Cowan, E. W., *Rev. Sci. Instr.*, **21**, 991 (1950).
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A CENTURY OF FORESTRY*

FORESTRY IN THE BRITISH COMMONWEALTH IN THE LAST CENTURY

By Prof. E. P. STEBBING

India, Pakistan and Burma

THE constant stream of immigration and invasion to which India was subjected during the 3,800 years which roughly elapsed between the invasion of the Aryans and the advent of the British as rulers witnessed the destruction of a very large proportion of the forests which originally covered great tracts of the country. The forests had, in fact, over large areas in some parts already been reduced below the minimum essential to the well-being of the country and its inhabitants by the beginning of last century, firewood being unattainable and timber transported over long distances by water carriage. The advent of the British had not made things easier, as heavy fellings were undertaken in accessible forests, especially teak forests in southern India and in southern Burma, to supply timber both for the Government's requirements in India and for the Admiralty at home.

It was more than a hundred years ago, on the initiation of Dr. Cleghorn, later conservator of forests in Madras (1855), at the meeting of the British Association in Edinburgh in 1850, that a committee was appointed to consider the destruction of tropical forests in India.

This was the result of the paper read by Dr. Cleghorn in which he recorded briefly the fellings of the teak forests as already mentioned. The outcome of these greatly increased uncontrolled fellings in the teak forest had resulted in erosion, silting up of rivers, streams, and so forth. It was a summary of the position which had thus arisen in south India, coupled with the habit of shifting cultivation of the population, which was considered in the report of the committee which was presented to the British Association at its meeting in 1851 (the committee consisted of Dr. H. Cleghorn, Prof. Forbes Royle, Capt. H. Baird Smith and Capt. R. Strachey, both of the Bengal Engineers).

A very good picture of the position of the forests of India in its different parts was included in this report, the first description of its kind that we had and the first intimation which we had of the rapid devastation which followed the destruction of tropical forests.

(* Continued from p. 134.)

In the following decade conservators had been appointed to most of the provinces of India and a policy was being introduced through which the Government forests at least were passing over from the hand-to-mouth policy of the preceding half-century to a more regular administration. These ten years, it may be said, were rather a matter of groping in the dark since the tropical forests were unknown from a working point of view; but it was to have the great assistance of an exceptional man when Dr. Brandis was appointed superintendent to Pegu in Burma in 1856. The year before, Lord Dalhousie, governor-general, had enunciated what was called "The Charter of the Indian Forests" when he laid down that no further fellings in Government forests were to be made until, first, the volume of timber available had been ascertained by the forest officer, and, secondly, the trees to be felled had been marked by the forest officer. This, broadly, was the main basis under which the former unchecked actions of the timber merchants were brought under control.

Towards the end of this period the Indian Mutiny took place, and as a result railway construction was projected practically throughout the length and breadth of India.

As a result of the dispatches between the Governor-General and the Secretary of State for India in 1862–63 the Indian Forest Department came into being in 1864, the main basis of the Department being an inspector-general of forests, Brandis, a conservator of forests in each province with deputy conservators and assistant conservators in charge of the forests of the different districts; a non-gazetted forest staff of rangers, forest guards, etc., was also recruited in each province.

During the period up to 1900 the chief work of the officers was the reservation of great areas of Government forests, created reserves under the Forest Acts VII of 1865 and 1875, in addition to departmental exploitation of timber, etc., for the markets and requirements of the people. During this period fire protection of the tropical forest was not only successfully introduced but also became an important part of the forest officer's work and perhaps the most remarkable part of it.

Brandis retired in 1882 and was replaced by Schlich as inspector general. One of the most significant works of Schlich was the preparation of a memorandum under which forest working plans were later prepared both in India and Burma. Preliminary and elementary as most of these plans were, they were the foundation of the great work in this direction the next century was to witness. Also from the late 'eighties onwards in the more advanced forests of India the welcome change from departmental working of the forests gave place to the employment of contractors who felled and extracted the trees marked in the forest blocks by the forest officer, thus freeing the forest officer for important professional duties.

By 1900 most of the heavy work in connexion with the selection and reservation of the Government forests was completed. Ribbentrop had succeeded Schlich in 1883–84, the latter going home to start forestry education in Britain at the Royal Engineering College, Coopers Hill. As indicating the progress that had been made in recognition of what forestry really meant to India, in 1894 the Government of India issued a Circular No. 22*F*. The principles of this circular are as true now as they were at that day. (*a*) First and foremost the preservation of the climatic and physical conditions of the country come before

all other objects; (*b*) the preservation of the minimum amount of forest necessary for the well-being of the country second only to (*a*) above; (*c*) agriculture and cultivation come before forestry in the use of the soil; (*d*) the satisfaction of the requirements of the local population, given either free or at reduced rates, comes before revenue; (*e*) with the above objects fully provided for, the realization from the forest area of revenue to the greatest amount which efficient management permits.

The next period 1901–25 saw the placing on a sound basis of sylviculture, research and working plans.

One of the first major questions in the early years of the twentieth century was the question of the value of fire protection in the moist teak forests in Burma. After thirty years of protection, it was discovered that young teak growth was almost absent. This statement was received with incredulity by the higher forest authorities and by the Government of India. For it was by then established that the fire protection of the past thirty years had resulted in a great improvement of the forests over large areas. It was only after the most careful proof obtained from sample plots and so forth that it was accepted that a low evergreen undergrowth had resulted in this moist forest through which the young teak seedling found it impossible to penetrate. Afterwards the same was found to be the case in the moist sal forests in Assam. This gave rise to various changes in the fire policy not only in the moist teak and sal forests, but also in other parts of India in which the so-called 'early burning', now widely known, made its first appearance.

The next great development was the formation of the Imperial Forest Research Institute at Dehra Dun in 1906. A few years before, Lord Curzon, the viceroy, had formed an Agricultural Research Institute for India. With Sir S. Eardley Wilmot's (inspector-general of forests) advice, Lord Curzon did the same for the Forest Department, which was now ready, as a result of the previous forty years work, to take full advantage of this opportunity to carry out research in several directions. Six branches of research work were formed, the heads of which were found from officers in the Department. Almost immediate success followed, for during the First World War the young Research Institute was able to afford the country, now shut off from many imports, advice and assistance in discovering substitutes. So successful was this work that the Government of India after the War submitted to the Secretary of State estimates for a great enlargement of the Institute, a new building to be built at a cost of one million pounds sterling. It is impossible to go further into this matter here. During the Second Great War the services of the Institute proved invaluable and could be offered on the grand scale.

The early years of this period had witnessed considerable increases to the staff of the Department. Many of the provinces had now several conservators instead of one only, the larger ones as many as six. A new grade of chief conservator was instituted to enable the governor of the province to have only one forest adviser instead of as many as six all holding the same rank. This resulted not only in the subdivision of the province into several conservators' charges but also of the several district charges, with the automatic increase of deputy conservators and assistant conservators and a greater intensity of management in the several district charges. This equally gave rise to a vast improvement not only in the number of working plans brought into force but in the increased intensity of management provided under these plans. In 1944 the inspector-general of forests, Sir Herbert Howard, was able to write on the subject of excess war fellings in the Government reserved forests in India: "Little is required to restore the departure from normal, that is, the excess war fellings; a 40–50 per cent reduction in pre-War yields for a period of 5 to 10 years may in some cases be necessary. The true position can be determined by the revision of the Working Plans which must, therefore, be accelerated after the war." Few other countries in the world could write that statement at the end of the War. I for one believe that India had at that period as fine a set of working plans as were to be found anywhere in the world. There were conservators of working plans in every province, as well as provincial research officers in sylviculture, utilization and forest entomology.

Great progress had been made in the study of the sylviculture of some of the more important species, and sylvicultural management had made great strides, the old selection system being replaced by more advanced sylvicultural systems; and even the method of the shifting cultivation, that enemy of the forest, had been brought in to assist in getting up new young crops of trees. Progress had been constant both in research and in execution in the field of working plan provisions, while the revision of these latter, now covering all the reserved forests of India and Burma, had become almost routine in its regularity. As a result of the work at the Research Institute, volume and yield tables for the main Indian species had been produced to accompany the introduction of the more classical European systems of management.

The Indianization of the forest service commenced to become evident from 1922 and steadily increased. It is impossible to go into this here. It led up to what is now the almost complete Indianization of India (both India and Pakistan) and of Burma.

Mr. F. C. Osmaston, a conservator of forests, who left India three years ago only, to join the staff of the University of Edinburgh, gives me the following summary: "The period of 1925–47 may perhaps be summarized as one in which the general structure of forest organization in the field was completed on the sound foundations laid earlier. This was shown not only in the expanding revenue resulting from a steady road programme and development of less accessible forests, but in the technical advances and adaptation of classical sylvicultural systems leading to a much higher production per acre. Moreover, the subjection of all reserved forests to working plans was a great achievement. This constant revision, incorporating continued improvements in technique or adaptation to market changes, had brought Indian forestry to a stage comparable with that attained by European Continental countries after several centuries of development."

I have not touched here on the progress of forestry education for India and its origins, as these are now well known both for the senior grades and the subordinate ranger staff; they commenced at Dehra Dun in 1885. I have equally avoided giving any figures for forest revenue and its advances and of the total forest areas of various categories. Both are easily obtainable from reference books and reports. But one point should be stressed. From the earliest time of recruiting for the Indian Forest Service by Brandis (1869–70) each year the number of proba-

tioners required was announced by the Secretary of State for India and published in the Press several months before the date of the examination or selection board. Each year educational authorities, parents and would-be probationers knew well beforehand what the prospects were for the year they were interested in. This procedure continued for nearly fifty years.

Canada

It is difficult to say how much influence the American Colonies, their discovery and early development had upon the forestry of the other Dominions. The presence of the great forest belt in America, stretching from the seaboard into the interior for interminable unknown miles, exerted an immediate effect upon the American settlers and the Government at home. The Admiralty soon began to make inquiries for oak timber for ship construction and conifers for spars. We had as competitors the French, who sent out special agents to inspect the forests for this purpose. There was no lack of timber. The supplies were regarded as inexhaustible, and the chief object of the Colonists was to get rid of the forest. Before the War of Independence this was well understood in responsible circles at home. The forest was in the way, was inexhaustible, and had to be got rid of. It may be asked what influence did this idea of the virgin forest exert on the Home Government when the other Dominions and their development came up for consideration.

Canada of necessity followed the new United States in its early forest treatment, being in a somewhat similar position. The chief population of Canada was concentrated near the United States boundary, which anyone can cross in a motor-car without hindrance, and, of course, they have similar monetary systems. Canada came into existence in 1867. So far as forestry development goes she has followed the American procedure on, until recently, far more restricted lines owing to her smaller population. She has a large forest area of which some half may at present be merchantable. During the past century exploitation of the accessible forests had been on an increasing scale to satisfy the demands for logs and square timber, fuel wood, railway ties, pitwood, posts and poles, as well as pulpwood. The extension of railways and the discovery of vast water-power has added momentum to the inroads on the forest; and above all the importance of wood pulp and paper-making in which by 1927 she had surpassed the United States. Recently Mr. D. A. Macdonald, director of resources and development, Forestry Branch, gave me the following information. Of the vast area comprising Canada only small fractions are covered by forest inventory. It will be some years yet before an inventory is available *for the productive forest area alone*, which is estimated at 800,000 square miles. With the exception of forest areas which have been deliberately cleared for agricultural purposes, it is doubtful if any areas exist where the forest at the source of a main river has been logged so as to leave a completely denuded area. The general policy of selection cutting has usually resulted in stands of timber remaining on the area, although not necessarily the same species as were exploited. The main forest areas of Canada are owned and administered by the individual Provinces each of which, with the exception of Prince Edward Island, maintains its own provincial forest service. Some of these are at present engaged in making up their forest inventories but none has been completed. As in the United States fire danger is a serious problem in Canada. She was one of the first to introduce the aeroplane to assist in fire fighting and she quickly made remarkable progress in this direction. She remains one of the world's three chief sources of virgin coniferous suppliers.

South Africa

Generally speaking, South Africa is a dry arid country, the small rainfall decreasing from east to west where desert conditions exist. Tree vegetation in the course of the recent centuries has been destroyed by the indigenous population and the European settlers. The director of forestry two years ago wrote to me as follows: "It could be said that the area of forest is almost everywhere negligible. In the mountains many streams have forest remnants along their banks; these would be hardly noticeable in a true forest country. The total area of natural forest is less than one quarter of one per cent of the Union and the largest area is in a narrow coastal strip between George and Humansdorp (the Knysna region) where no important river rises." As is well known, South Africa has been engaged on afforestation work since before the First World War. The director wrote: "Afforestation with exotic species has been undertaken and plantations of Wattle (chiefly *Acacia mollisima*), pines and Eucalypts, including private and Government plantations, cover 1,825 square miles which is less than half of one per cent of the total area of the Union (472,550 square miles)". Considerable forest research work has been carried out.

Australia

In Australia it is admitted that a century and a half ago the first settlers found a land which appeared to be one vast forest in which the nomadic aborigine was so primitive that he had not acquired the art of tilling the soil. One hundred and fifty years later, owing to the rapid development, nearly all the land capable of growing crops or of raising flocks and herds had been wholly or partially worked. Fortunes were made; but the misuse or overuse of the land upset Nature's balance, and their greatest national resources, soil and water, have been impaired and in places ceased to yield any return. An Australian has said: "Erosion by wind and water, the well-known 'soil-drift', has taken a great hold over considerable areas which have been turned into deserts. In the mountains overgrazing and fires have attained dimensions which endanger the catchment areas of the waterways and rivers, like the Murray, which are not confined to one State but on which two or three are dependent for water and irrigation. Floods are becoming more serious and rivers once secure between their forested banks are tearing away alluvial soil and bearing it down to the sea." The presence of the North to South Dividing Range adjacent to the eastern coast of Australia is one of the contributory factors in the uneven distribution of rainfall on the continent. With the exception of certain tropical areas the principal commercial forests are mainly located in the areas of higher rainfall, that is, along the coastal sides of the Dividing Range in Queensland, New South Wales and Victoria. They also occur in isolated areas in south-west Victoria, South Australia and South-western Australia. It is realized that the area of 24·5 million acres of existing forest is below what is required.

In Tasmania the 1·7 million acres of forests are located in the extensive areas with a rainfall of 30–100 in.

The Commonwealth of Australia came into being in 1901, but excessive fellings and overuse of the soils continued unabated for the next twenty-five years and fires added to the destruction. Eucalypt timber was extensively exported.

A National School of Forestry was established at Canberra in 1927, and during the second quarter of a century considerable progress has been made in scientific forestry with a Research Bureau which has accomplished valuable work. The remarkable discovery, for it was almost a discovery, that paper pulp could be manufactured from the Eucalypts has led to an industry of rising importance. The introduction of conifers, especially the *P. radiata*, to form plantations to lessen the softwood imports, is also significant. As in Canada the aeroplane has been introduced in fire protection work.

Probationers for the upper services receive their forestry training at some of the universities (as, for example, Queensland) or go to the National School of Forestry at Canberra.

New Zealand

It is just a century since self-government was granted to New Zealand, the area of which is 103,000 square miles. The same treatment of the forests was adopted in the early years as elsewhere in the world—unchecked fellings for local use and exports, wholesale fellings to clear the land for cultivation or pasture lands coupled with uncontrolled fires which destroyed large areas of valuable forest. It was in the closing years of last century that the Government began to become aware of the increasing dangers which were resulting from the wholesale destruction. The chief areas of commercial forest had disappeared, the hardwood areas of *Nothofagus*, etc., being unknown and uncommercial. An afforestation section of the Lands Department was made in 1896, and the first attempts at the introduction of exotics, eucalypts, larch and pines were made with the usual varying success. At the end of the First World War a State Forest Department was formed and Forest Acts were passed in 1921–22. The Forest Department started extensive softwood plantations. This example was taken up by private companies and to such an extent that the Forest Department was able to reduce its afforestation activities. The commonest pine was *P. insignis*. The usual dangers from pests arose with the large areas of the new species planted over the countryside. A small beginning had been begun with research by the State Department. With the increasing areas owned by the private companies these amalgamated with the Government Research Station and a fully equipped research institute was formed.

Here again, as in Australia, a paper pulp industry has been started which should have a great future.

In the past twenty-five years the energies of the Department have been concentrated in acquiring, surveying and stock mapping of State forests, in improving forest protection methods, in sylvicultural research and soil conservation. But as recent reports have pointed out, fire is still one of the greatest dangers, and increasing desiccation and aridity in parts of the Dominion are by no means troubles of the past.

Forest education up to standards required for entrance into the State Forest Departments of the Dominions is given at certain of the universities which have established forestry faculties or schools. The education of the subordinate executive staff is also provided for.

The Colonies

Generally speaking, the history of forestry development in the Colonies started at the beginning of this century, though some were much later. In the last fifty years of the past century exploitation of accessible forests of valuable timber was the main objective; another, the clearance of the forest to make way for tea and coffee gardens and so forth. The subject is here treated under the head "Colonies", though these are divided into Crown Colonies, Protectorates, Protected States and Trust Territories. The greater part of the Colonies lies within the tropics, the total land area of the Colonial Empire being just over two million square miles, of which more than three-quarters lie in Africa. The total population is approximately sixty million.

The Colonies may be divided into five geographical groups: (1) The Caribbean Colonies. (2) West Africa. (3) Central and East Africa. (4) The Malay Peninsula and Archipelago. (5) The South-West Pacific Islands.

I regret that I am unable here to include the Sudan, about which I should have liked to have said something.

As has been said, unchecked and uncontrolled exploitation took place until towards the end of last century. Indian forest officers helped to introduce forestry methods into Ceylon, Cyprus, Mauritius and Nigeria during this period. With the formation of forest services in various Colonies in the early years of the present century, some Indian forest officers served in them after starting the departments—for example, British Honduras and British Guiana, Trinidad, the Gold Coast and Nigeria and in East Africa and Malaya. Ceylon had had an Indian forest officer, nominated for a period of years, as conservator since the 'nineties of last century. Also the Secretary of State for the Colonies had begun to recruit trained men from home for these new Departments, the first qualified men being appointed to Trinidad and Malaya in 1901.

The Forest Departments in the various Colonies were formed as follows: Kenya 1902; Nigeria and Uganda 1903; Gold Coast and Sierra Leone 1909 and 1911 respectively; North Borneo 1915; Nyasaland and Palestine 1920; Sarawak and Tanganyika 1919 and 1921; British Honduras and British Guiana 1922 and 1925; Northern Rhodesia 1929; Jamaica 1937; Fiji 1938; and in Gambia a forestry adviser was appointed in 1950.

In the period 1920–39 some definite progress had been made in certain Colonies, but it had been interfered with by want of continuity in correct forest administration or its introduction by two obstacles: the first the failure of the various Governors to recognize the importance of the Forest Departments to the countries as a whole and the consequent realization of the kind of staff required and its numerical maintenance, and secondly, the fact that a fall in the finances of the country was usually met by a reduction in staff and stoppage of recruitment at home. Malaya was an exception. By the early 'thirties she had a staff, area for area, numerically as large as the Indian Forest Service. The

Secretaries of State for the Colonies changed so continually that forestry could have meant little to them.

By the outbreak of the Second World War it was generally thought that a forest department should be a potential source of revenue and that a drop in revenue should be followed by a cut in the department's activities. Lip service had been given periodically in the various annual forestry reports to the value of the forests to the people and the country and their protection; but exploitation proceeded without a previous knowledge of the possibilities of the forests and the amounts of timber which could be taken out. The Second World War, therefore, found the Colonies once again unprepared, and uncontrolled fellings took place which the paucity of the forest staff were unable to oversee.

That some recognition of the position of the forest departments which possessed the trained men capable of carrying out their job, but had not the staff to give effect to their proposals, had become apparent at home in 1939 is shown by the statement made in 1939 by the Secretary of State for the Colonies: "Forest Departments are becoming more and more involved in the study of general rural development and land use and contacts between them and other Departments engaged on similar work have been strengthened". It was the failure of the Secretary of State to initiate any regular system of annual recruitment for the various Colonies for which he was responsible, such as was followed by the Secretaries of State for India for over half a century, which resulted in overcutting to meet the urgent large demands.

The War proved the value of the forests of the Colonial Empire but unfortunately added largely to the already uncontrolled exploitation carried on between the two Wars and preceding years.

Extensive planting which commenced sporadically in the early years of the century was carried out of exotics in many Colonies, chiefly of tropical or semi-tropical species such as teak, *Cassia*, *Gmelina*, neem, *Cedrela*, *Acacia*, some eucalypts and various species of pines. Some of these have proved themselves; but it has not yet been possible to ascertain for how long short rotations can be taken off the same soils, nor the dangers which may supervene from pests, insects and fungi. But the growth of these short-rotation exotics has greatly helped to solve the firewood situation in big towns where other fuel is non-existent.

It is impossible to mention the progress of Colonies since the end of the War (1945) by name. Considerable progress has been made by some in the assessment of the volume content of now accessible forests and to introduce the necessary control of fellings to keep within an ascertained sustained yield; in other cases a plan of forest management has been put into force which would include exotics where used for fuel plantations. In many Colonies the reservation of the area of forests requisite for the requirements of the country is far from complete. Progress in forestry research has been notable; but at times has been overstressed at the expense of the heel-and-toe work of correct administration in the forest itself. The progress in the training of native subordinate ranks is reassuring.

Dr. Fairbairn, who served in Nigeria and has recently joined the Edinburgh Forestry Department, writes as follows: "Mention may be made of the Colonial Development Corporation which had wholeheartedly initiated forestry progress in a number of colonial areas; without doubt great advancement can be made if the principles of scientific and sound economics are followed. It is the duty of the Forestry Departments and the Colonial Administrators to see that reasoned exploitation with adequate sylvicultural precautions for the replacement of the forest vegetation—not merely of the economic species—is assured." I agree.

It may be suggested in conclusion that the most important action which the Secretary of State for the Colonies can take to assist and safeguard the sound advances being made in forestry administration in the several Colonies is to see that a definite recruitment in trained gazetted staff is annually ensured on the basis required for each Colony. For all future progress in the interests of the community, and the correct forest area to maintain in its interests, depends upon this important factor.

Both Dominions and Colonies are sadly behind in one of the chief requirements of a properly managed forest area. I speak of working plans. It is to be regretted that they did not make a closer study, between the Wars, of the lines upon which India with over half a century of progress had developed her forestry practice. Research in utilization and in sylviculture was taken up with keenness in both, but the Second World War showed how much the forest is at the mercy of man in sudden demands; and there were few working plans in force in many of either Dominion or Colonial forests to regulate the war fellings.

OBITUARIES

Prof. H. S. Raper, C.B.E., F.R.S.

Henry Stanley Raper was educated at Bradford Technical College and at the University of Leeds, where he studied chemistry under J. B. Cohen; he graduated with first-class honours in 1903. His first published work, in collaboration with Cohen, was on positional isomerism and optical activity; afterwards he proceeded to the Lister Institute with a research scholarship. He also studied for a time in Germany. His interest in biology being stimulated, he returned to Leeds and completed the medical course in 1910. He afterwards held an appointment as lecturer in pathological chemistry in the University of Toronto, but returned to Leeds in 1913 as lecturer in physiological chemistry. During the War which followed, he did invaluable work at the Royal Engineers' Anti-gas Establishment, becoming commanding officer with the rank of lieutenant-colonel, and receiving the C.B.E. Soon after his return to Leeds he became professor of physiology and biochemistry. In 1923 he was appointed to the chair of physiology at Manchester and he occupied it with great distinction until 1946. He died on December 12 at the age of sixty-nine.

Raper's research interests naturally lay along chemical lines. His principal contributions to knowledge are on the metabolism of fats and in connexion with the tyrosinase – tyrosine reaction. In the field of fat metabolism he published in 1925 in conjunction with J. B. Leathes a classical monograph. The tyrosine studies led him to consider adrenaline formation and the origin of melanin. Latterly he was associated with Harper in work on the separation of secretin and pancreozymin.

His outstanding work was recognized by his election in 1929 to the fellowship of the Royal Society, on the Council of which he afterwards served; he was an honorary Fellow of the Royal College of Physicians. He also served as a member of the Medical Research Council. The University of Leeds conferred the degree of LL.D. upon him in 1943.

In 1946 Raper became full-time dean of the Medical School at Manchester, and by his wisdom and tact was responsible for the smooth operation of the changes in the pattern of medical education which resulted from the passing of the National Health Act. His wide experience was of great value also in the deliberations of the General Medical Council, in the educational work of which he took an important part.

Raper's death took place a few weeks before he was due to retire, and it was characteristic of the man that he should have continued unobtrusively and effectively at work right up to the end. In his personal character he was remarkable for modesty and for his kindly interest in everyone who came in contact with him, young and old alike. As the head of a department it was his policy to encourage by all the means in his power the independent research projects of his younger colleagues; in this way he succeeded in maintaining a variety of interests and of outlook in the teaching for which he was responsible. He was a redoubtable opponent on matters of principle, and his case was always based on complete intellectual honesty; but he was prepared to listen patiently to another's point of view, nor were disagreements ever allowed to affect his universally friendly relations with his colleagues.

Apart from his work, Raper's interests lay in water-colour painting. Though somewhat defective in colour vision, he had a keen appreciation of form and by his enthusiasm encouraged members of his staff to cultivate such talents as they had for sketching. In his younger days he was a keen cricketer, but latterly had given much attention to the magnificent garden of his house at Prestbury.

In Raper's death physiology has sustained an irreparable loss. His pupils, many of whom now occupy important posts, will always remember his teaching and will strive to be worthy of his incomparable example.

W. Schlapp

Miss E. C. Higgins

Ellen Charlotte Higgins, principal of the Royal Holloway College during 1907–35, died in Edinburgh on December 13. Born in London in 1871 of Scottish parents—her maternal grandfather being David Ramsay Hay (see "Dictionary of National Biography")—she was educated at Edinburgh Ladies' College and at the Royal Holloway College, London. She achieved the unique distinction of being placed in the first classes, in the same year (1894), in final honours mathematics at Oxford (an examination then open to Royal Holloway students) and in B.A. (Honours) English, with the Gilchrist Prize, in London. She was on the staff of Cheltenham Ladies' College during 1895–1907, latterly as head mathematics lecturer, and had been a governor of that College since 1924. She was chairman of the house committee of St. Gabriel's Church of England Training College for Women during 1932–44. From 1911 until 1935 she was a member of the Senate of the University of London, taking an ever-increasing share in its business; towards the end of this time she was on four of its five standing committees, as well as the finance and general purposes committee. In particular, she did notable work as chairman of the Matriculation Board (later the Matriculation and School Examinations Council).

The Royal Holloway College advanced in status and reputation during her many years as principal. Its distinguished first holders of professorships in the University of London were appointed; until 1922 these were all in science—Margaret J. Benson (already a college lecturer), botany, appointed 1912; G. Barger, chemistry, 1913, followed by T. S. Moore, 1914; F. Horton, physics, 1914; A. E. Jolliffe, mathematics, 1920. The chemistry building was extended, and in 1926 a building providing good new laboratory accommodation in physics and botany was opened. Students, as well as junior members of the staff, who came under Miss Higgins, later obtained many of the highest academic and scholastic posts open to women or attained distinction in a variety of other careers. The student body became, as it still is, a well-united society capable of concerted effort when required. Miss Higgins maintained dignity and spaciousness in the domestic life of the College and in its public occasions. The benefit of her care for its furnishings is still felt in the present more austere times.

Miss Higgins belonged perhaps more to the pioneering days of university education for women than to the time when their full participation in all academic pursuits is taken for granted. Thus, although the research work of individual colleagues flourished in her time, she scarcely contemplated her College becoming a centre of research as it has done in recent years (when men, as well as women, have been admitted as postgraduate workers). Yet the ease with which this development has occurred is a tribute to the level to which she had done so much to raise the College.

Except in private life, Miss Higgins was brusque in manner. Behind this façade, she was warm-hearted and constantly performed acts of kindness which she herself revealed to none but their recipients. Her independence and practicalness, combined with her concern for the ceremonies of life, found expression in her quite famous clothes—her invariable and rather mannish day-attire and her magnificent but fashion-defying evening-dresses. Until her last brief illness, her vitality remained almost unimpaired: she was an enthusiastic and experienced alpinist, and made her last ascent to the Matterhorn hut at the age of seventy-six.

W. H. McCrea

Dr. Ivar Tragardh

The death occurred at Stockholm, on May 22, 1951, of Dr. Ivar Tragardh. Ivar Tragardh was born on September 16, 1878, at Jarfalla, near Stockholm, and studied at Uppsala. In 1901 he became a member of the Jagerskiold expedition to Egypt and the Sudan, and in 1904, with the help of the Vega Fund, he visited Natal and Zululand. He obtained his Ph.D. degree in 1905.

In 1910 Tragardh was appointed assistant in the Department of Entomology, Centralanstalten fur Jordbruksforsok, Stockholm. From 1915 until 1944 he was professor and chief of the Department of Entomology, Forestry Research Institute, at Experimentalfaltet, Sweden.

With the aid of a Zorn and Rockefeller grant he visited Canada and the United States, and was Swedish Government representative at the Fourth International Congress of Entomology at Ithaca, New York. He retired from his official post in 1944 at the age of sixty-five and in 1948 was president of the Eighth International Congress of Entomology, held at Stockholm.

During his life, Tragardh published some 210 scientific papers, 141 of which were on entomology, the remainder being on acarology. In entomology his best-known work is "Svenska Sogsinsekter", published in 1914. In his later years he specialized on the mites, and did much to clarify the taxonomical and morphological problems which existed. Although suffering from eye trouble, his work on the Mesostigmata continued, with many detailed drawings to add to the value of his excellent papers. He described some fifty-six new genera, 171 new species and twenty-three new varieties in the order Acarina. He had an excellent command of the English language and many of his papers were printed in English.

In 1950 Tragardh had an operation for cataract which was followed by a second operation in 1951, culminating in his death in May. His death not only deprives Sweden of one of its eminent men of science but also comes as a great loss to acarologists in particular. For a time prior to his death he was much taken up with the idea of founding (with Dr. Marc André, Paris, and Dr. Charles D. Radford, Manchester) the Société Internationale d'Acarologie, proposals for which were announced at the 1948 Stockholm meeting. He leaves a widow and a daughter.

We regret to announce the following deaths :

Sir Peter Clutterbuck, C.I.E., C.B.E., inspector-general of forests to the Government of India during 1921–26, and chairman in 1927 of the Forestry Sub-section of the British Association, on December 20, aged eighty-three.

Mr. C. J. T. Mackie, assistant secretary since 1924 of the Institution of Chemical Engineers, on January 8.

Sir Reginald Stradling, C.B., F.R.S., dean of the Military College of Science, on January 26, aged sixty.

NEWS and VIEWS

Psychology at Cambridge : Sir Frederic Bartlett, C.B.E., F.R.S.

Frederic Charles Bartlett went to St. John's College, Cambridge, in 1911, and took his degree in moral sciences in 1914. He was elected a Fellow of his College in 1916. He acted as assistant to Dr. C. S. Myers, the first director of the Psychological Laboratory, during 1915–22, and succeeded him as reader in 1923 ; in 1931 he was made professor. Bartlett took up psychology at a critical period in the development of a young subject. Originally he was primarily interested in anthropology, and this interest has never left him. He has always regarded psychology as the study of man's behaviour in his ordinary surroundings. His approach was strictly experimental, and he had no use for theoretical generalizations with inadequate experimental bases. He made no effort to form a school of psychology seeking to explain wide ranges of mental phenomena by some preconceived theory ; he preferred to confine himself to experiment and the conclusions it yielded. His own work on memory was a valuable and original contribution, which has greatly influenced the work of others. It broke away from much of the previous work on the subject with its artificially constructed test situations, and was an experimental study of what people did in fact remember, forget or conventionalize.

Bartlett to a large extent gave up his own researches in order to direct those of others. He always regarded his Department as primarily concerned with research rather than teaching. Naturally, teaching was provided and brought closely into touch with current research ; but the emphasis was always on research. During the years, he collected an ever-growing body of research workers from his own students and also graduates from other universities, and a large volume of work has come from the Psychological Laboratory at Cambridge. He is a trenchant critic ; but his criticism is never trivial and always constructive, and much work that has appeared under the name of others has been enriched by his criticism. Much of the work that was done in the Laboratory between the two World Wars yielded results that were immediately applicable to many Service problems, and during the War Bartlett's aid was constantly sought by each of the Defence Services. His work in this sphere has had a lasting effect within the Services themselves, and added greatly to our general knowledge of psychology. When Bartlett went to the Department of Psychology at Cambridge, it was small ; he leaves it greatly enlarged in size, with every sign of continued development based on the independent work of its members, which he has always so carefully fostered.

Mr. O. L. Zangwill

O. L. Zangwill, who succeeds Sir Frederic Bartlett, is a son of Israel Zangwill, the writer and novelist. Partly owing to the influence of Dr. C. S. Myers, who was a friend of his family, he decided while he was still at school that psychology should be his principal subject of study. He went up to King's College, Cambridge, in 1932 and adopted the course—very rare at that time, but now common—of first reading for the Natural Sciences Tripos, then going on in 1935 to a final honours degree in psychology. He spent the next three years in the Cambridge Psychological Laboratory doing research work, principally upon certain problems of remembering, recognition and related topics which had been the subject of considerable recent work in the Department. Among the problems which attracted his particular attention were various developments of the fundamental ideas which had been used by Sir Henry Head in his work on afferent sensitivity and on aphasia. Together with R. C. Oldfield, Mr. Zangwill published a penetrating criticism of these developments. For a year, 1938–39, he held a personal grant from the Medical Research Council for projected work on 'incentives', but the War interrupted this research, and it was a natural thing for him to join the group led by Sir

D. K. Henderson and Dr. Norman Dott, who, supported by the Rockefeller Foundation, were working at Bangour on head injuries. There he continued throughout the war years. Later he worked with Sir Hugh Cairns at the Oxford Head Injuries Unit and also joined the Institute of Experimental Psychology of the University of Oxford, where in due course he became a senior lecturer. The marked development of this Institute during the past few years has been largely due to Mr. Zangwill's judicious and successful leadership. His immediate research interests lie chiefly in the study of the connexion of specific psychological functions with cerebral activities, but he is far from being a first-rate specialist only. His article on psychology in the new edition of "Chambers's Encyclopædia" bears comparison with Prof. James Ward's famous contribution on the same subject to an earlier edition of the "Encyclopædia Britannica". His recent book in the Home University Series shows that, while he has decided opinions of his own, he has also a tolerant and wide outlook and an extensive and profound knowledge of psychology which few, if any, of his contemporaries can rival.

Hundred Years of Instrument Making

The firm of Negretti and Zambra (122 Regent Street, London, W.1) has issued, in celebration of the completion in 1950 of a century of instrument-making activities, an attractive booklet, containing many historical illustrations, which provides a brief history of the firm and indicates the milestones in its progress. From 1850, the year of its foundation, until 1914, Negretti and Zambra was almost entirely engaged in the development and production of meteorological instruments, and, in the mind of the general public, the firm was perhaps identified with the weather and its vagaries. It is apparent, however, from the account given of the developments and inventions of the firm in this field, that the science of meteorology is in no little debt to this firm. There is also a clear indication of the very personal relations which existed between the scientific instrument maker and the user of scientific instruments before the period when the widely extended use of scientific instruments made the continuance of these relationships very much more difficult. A number of instances are quoted in the centenary booklet of the users of meteorological instruments approaching members of the firm in order to discuss their problems, and Mr. E. A. L. Negretti was often present at the trials of new instruments by, for example, the Admiralty. The exigencies of the First World War imposed upon the firm the task of extending the field of its instruments, and, in particular, Negretti and Zambra commenced the production of process-control instruments. While the firm still retains its relation to meteorology, it is to-day just as well known for the part it plays in the control of industrial processes. The history of this firm provides an excellent illustration of the evolution of the modern scientific instrument industry. Scientific instrument manufacture, which existed in Great Britain before the time of Sir Isaac Newton, pursued an interesting, but placid, course for some centuries. The period of the First World War separates the old scientific instrument industry from the new. To-day it is an industry essential to the health of all other industries, and the account given of the activities of this latest recruit to the select body of British scientific instrument makers having more than a century of continuous existence evokes memories of a more leisurely past while indicating the present very wide field of the usage of scientific instruments.

Chemical Engineering Science : Genie Chimique

A new periodical is apt to arouse suspicion and evoke the question, "Is it really necessary ?" It may be said that two conditions must be fulfilled for a newcomer to be regarded as a journal of importance : the first is that the contents must be of high quality ; and the second that it serves as a medium for publishing work which might not otherwise reach those to whom it is of interest. As regards the first requirement, there can be little doubt of its fulfilment by *Chemical Engineering Science : Genie Chimique*, an international monthly the first number of which appeared last October (Pergamon Press, Ltd., 2–5 Studio Place, Kinnerton Street, London, S.W.1 ; 90*s*. a vol.). There are seven editors, all chemical engineers of high standing, residing in France, Great Britain, Italy, Switzerland, Belgium, Holland and Norway, and an advisory board of nineteen from eleven countries. Six original papers of high quality occupy fifty quarto pages very clearly printed by the Würzburg University Press, and it is hoped to publish in English, French or German not only papers dealing with the principles of chemical engineering but also detailed notes on advances in industrial processes. The second requirement may also be regarded as met. As explained by Prof. J. Cathala in an introductory paper, one of the reasons for the recent spectacular successes of the American chemical industry and the swamping effect of American chemical engineering literature is that chemical engineering has for many years been recognized in the United States as a definite and independent branch of technology. In Europe there are many chemical engineers with the highest qualifications ; but, particularly on the Continent, they are not often given a distinctive name, and there is no common journal in which their work can be published. In consequence, much valuable material is apt to be overlooked. British chemical engineers, who already have at least three periodicals to which they themselves normally contribute, will particularly welcome this new and valuable means of bringing to their notice work which is taking place in the countries around them and will wish the new publication every success.

Oceanographical Expedition to the South Atlantic

It has been announced from the Woods Hole Oceanographic Institution, Woods Hole, Mass., that the research vessels *Atlantis* and *Albatross III* have recently left Cape Cod, Mass., to make a thorough investigation of the equatorial currents between West Africa and the South American coast. Observations will be made of ocean temperatures and salinity, chemical nutrients in solution in the water, strength and direction of currents, microscopic life and the relation between the trade winds and the ocean currents. The scientific work on board the *Atlantis*, a 142-ft. ketch, will be in the charge of Dr. Bostwick H. Ketchum, a marine bacteriologist, while aboard the *Albatross III*, a 185-ft. steel trawler chartered from the United States Fish and Wildlife Service, Dr. Francis A. Richards, a chemical oceanographer, will be the scientific director. The investigations of ocean currents will be under the supervision of Frederick C. Fuglister and Columbus O'D. Iselin,

jun. The ships will each sail about 15,000 miles and the oceanographical expedition will last about three months, during which calls will be made at Bermuda, Dakar, Recife and Barbados. The vessels will then go to Trinidad, where a new scientific party will take over for a two-week geological survey in the Gulf of Mexico.

Edmund Johnston Garwood Fund of the Geological Society

THE Council of the Geological Society of London has accepted a trust for the establishment of a fund to provide "an annual award . . . as a permanent memorial of the regard and esteem entertained . . . for the life and work of the late Edmund Johnston Garwood". The Fund is the gift of Prof. Garwood's executors and will provide an annual sum of about £30, which will be awarded by the Council to "a Fellow of the Society whose current and prospective work and research (whether in the United Kingdom or elsewhere) in the subjects of Stratigraphy and Palaeontology or Physical Geology is . . . deserving of such recognition". The award is intended to encourage and assist the initiation or continuance of research rather than to reward past work, and recipients must be between the ages of twenty-eight and fifty-one. It is proposed to make the first award in the near future. Prof. Garwood was Yates–Goldsmid professor of geology in University College, London, from 1901 until his retirement in 1931, when he was made an emeritus professor in the University. He was president of Section C (Geology) of the British Association in 1913 and was elected to the Royal Society in 1914. His services to the Geological Society included terms of office as secretary during 1905–12 and president during 1930–32. His principal contributions to geological knowledge were in the fields of research which the new fund is intended to encourage, and in particular on the faunal succession of the Lower Carboniferous rocks, on the calcareous algæ and on glacial action. He died in 1949.

University of Birmingham

THE following announcements have recently been made by the University of Birmingham. F. E. Round has been appointed a lecturer in botany. The degree of D.Sc. (industrial fermentation) has been conferred on A. C. Hulme. The following have resigned from the University: Dr. G. J. Kynch, lecturer in mathematical physics, on appointment as professor of applied mathematics, University College, Aberystwyth; P. B. R. Gibson, lecturer in engineering production, on appointment as senior instructor, Department of Management Studies, R.E.M.E. Officers Training Centre, Arborfield; Dr. K. Butler, lecturer in chemistry.

Announcements

PROF. C. H. BEST, professor of physiology and director of the Banting and Best Department of Medical Research, University of Toronto, will preside at the Nineteenth International Physiological Congress, which will be held in Montreal during August 31–September 4, 1953.

THE May Lecture to the Institute of Metals will be delivered by Dr. J. J. P. Staudinger, a director of British Resin Products, Ltd., Barry, on "The Place of Plastics in the Order of Matter". The Lecture will be given at the Royal Institution, Albemarle Street, London, W.1, on Monday, March 24, at 6 p.m. Visitors will be welcome; tickets are not required.

THE third annual meeting of the Histochemical Society will be held during April 7–8 at the Hotel New Yorker, New York, N.Y. Papers to be read should be submitted to the secretary, Dr. R. D. Lillie, National Institutes of Health, Bethesda 14, Maryland.

THE Institute of Personnel Management is holding a five-day study course on "Education and Training", to be held at the Coburg Court Hotel, Bayswater Road, London, W.1, during February 10–15. The course, which is limited to about twenty members, is designed for education officers, training officers and personnel officers responsible for training, and is devoted to the practical side of personnel management. The fee for the course is 10 guineas (8 guineas for members of the Institute). Further details can be obtained from the Courses Secretary, Institute of Personnel Management, Management House, 8 Hill Street, London, W.1.

A SECOND symposium, on information theory, to follow the one held in September 1950 (see *Nature*, **167**, 20; 1951), will be held at the Institution of Electrical Engineers during the week commencing September 22, and will deal with applications of this theory in the field of telecommunications. A preliminary programme of papers to be presented has been prepared, and offers of additional papers from both Great Britain and abroad will be welcomed. Further details can be obtained from Prof. Willis Jackson, Electrical Engineering Department, Imperial College of Science and Technology, London, S.W.7.

THE third annual meeting of the Society for the Study of Fertility will be held in the Meeting House of the Zoological Society of London during June 27–28. Papers will be read on subjects covering the whole field of fertility and sterility, from the biological and veterinary as well as medical points of view. One of the sessions will be devoted to a symposium on sperm morphology. The meeting will be open to any qualified person with an interest in the field of fertility, and those who are not members of the Society should communicate with the honorary secretary, Dr. G. I. M. Swyer, University College Obstetric Hospital, Huntley Street, London, W.C.1, from whom further particulars can be obtained.

THE Ministry of Agriculture and Fisheries is offering the following scholarships for rural workers or the children of rural workers of seventeen years of age or more: ten senior scholarships, tenable at universities or colleges, for degree or diploma courses in an agricultural subject or veterinary science; sixty junior scholarships (and six extensions for existing holders), tenable at farm institutes, for one-year courses in agriculture, horticulture, dairying or poultry husbandry. Selection is by interview only. Further information and forms of application (to be completed by March 31) can be obtained from the Secretary (Room 314), 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from the education offices of County Councils.

ERRATUM. In the article "The Theory and Practice of Ion Exchange" (*Nature*, January 5, p. 22, second par.), for $[Zr(OH)NO_3]^+$ read $[Zr(OH)_2NO_3]^+$.

CHLOROPHYLL-LIPOPROTEIN OBTAINED IN CRYSTALS

By SHIRO TAKASHIMA

Botanical Institute, University of Tokyo; Tokugawa Institute for Biological Research, Tokyo

ALTHOUGH ample evidence has now accrued that, in living leaves, chlorophyll exists in molecular combination with protein, the attempt at isolation of the protein in pure crystalline form has met with repeated failures. By the following procedure we were able to obtain a crystalline and carotenoid-free sample of chlorophyll-lipoprotein which was found to contain two molecules of chlorophyll per molecule of lipoprotein with a molecular weight of about 19,000.

Fresh leaves of *Trifolium repens* were thoroughly ground with fine quartz sand with gradual addition of four or five volumes of phosphate buffer ($M/50$) of *p*H 7·0. The mixture was centrifuged at 2,500 r.p.m. for 20 min., and the supernatant was filtered through ordinary filter paper. The green opalescent filtrate was found to contain many small particles (grana), which under the electron microscope showed themselves to be fairly uniformly shaped rods with the length of about 0·7–1·2 μ and the width of about one-fifth of the length. To this suspension α-picoline was added with stirring to form a 50–55 volume per cent solution of the latter; the mixture immediately lost its opalescence, giving rise to a clear solution in which no more grana could be detected. This solution showed stronger fluorescence than the original suspension.

The solution was then dialysed for about twenty hours in 'Cellophane' against 50–55 per cent picoline–water, during which time fine yellowish-pink crystals appeared within the membrane. By its form (hexagonal plates), solubility in various organic solvents, as well as by the absorption spectrum of its benzol solution (absorption maxima at 463 mμ and 492 mμ), this crystalline substance was identified as carotenoid. The crystals were removed by filtration, and to the filtrate dioxane was added to form a 20 per cent solution. On keeping the mixture in an ice-box, dark-green crystals appeared within four to seven days, which were found under the microscope to be spherical aggregates of fine needles. These crystals were collected by centrifugation and dissolved in a 55 per cent picoline solution in 0·006–0·01 M phosphate buffer of *p*H 7·0. The solution was filtered through filter paper, and to the filtrate dioxane was added to form a 20 per cent solution. On keeping the solution overnight in an ice-box, the green chlorophyll-lipoprotein recrystallized out in the form shown in Fig. 1.

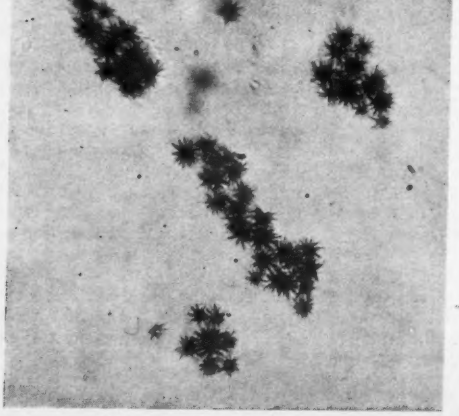

Fig. 1. Recrystallized chlorophyll-lipoprotein. × 480.

The solution of the crystallized substance gives positive ninhydrin, xanthoproteic and biuret reactions. By treatment with ether – alcohol mixture (1 : 1) the sample lost 38·8 per cent of its dry weight, indicating the lipoprotein nature of the substance. Elementary analysis gave the following figures: C, 51·73 per cent; H, 7·17 per cent; N, 8·48 per cent; ash, 3·38 per cent. The molecular weight of the purified sample was measured by the osmometric method of Bull[1] using 55 per cent picoline–water as solvent and 'Cellophane' as the semi-permeable membrane. By this method the molecular weight (M) of the protein can be calculated from the equation:

$$M = 2{\cdot}53 \times 10^7 \times \left(\frac{c}{h} \cdot \frac{\rho}{\rho'}\right)$$

(at 25° C.), where c is the number of grams of protein dissolved in 1 c.c. of solution, h the height (in cm.) of the solution column corresponding to the osmotic pressure caused by the protein, ρ and ρ' the densities of the solvent (picoline–water) and its solution of protein, respectively. Measurements were carried out at 25° C., using protein solutions of different concentrations ranging from $0{\cdot}18 \times 10^{-3}$ to $1{\cdot}3 \times 10^{-3}$ gm. per c.c. of the solution. The curve obtained by plotting c/h against c is reproduced in Fig. 2. By extrapolating the curve, the value c/h corresponding to the point $c = 0$ was estimated to be $7{\cdot}6 \times 10^{-4}$ gm./c.c.-cm. Applying this value in the above equation and assuming ρ' to be equal to ρ because of the low concentration of the solute used, it was found that the molecular weight of the protein in question is about 19,200. This value is remarkably smaller than those estimated by means of the ultracentrifuge method by Wyckoff *et al.*[2] (500,000, using green aqueous solutions obtained from cucumber and green pea leaves) and by Smith *et al.*[3] (265,000, using samples from spinach leaves treated with certain detergents).

To determine the molecular ratio of chlorophyll to protein, the chlorophyll in the weighed samples was extracted with acetone, treated with $N/10$ hydrochloric acid, and the phæophytin formed was extracted with ether, transferred into benzol, and the quantity of phæophytin was determined spectrophotometrically at wave-lengths 510, 535, 610 and 670 mμ. The results of several measurements gave the average value of 1·71 gram moles of chlorophyll per 19,000 gm. of the sample. It may be concluded that the crystallized substance contains two molecules of chlorophyll per molecule of lipoprotein. According to Smith[4], the chlorophyll-protein from *Spinacia* and *Aspidistra* leaves contains 16·1 parts (by weight) of chlorophyll per 100 parts of protein, that is, 5,600 gm. of protein

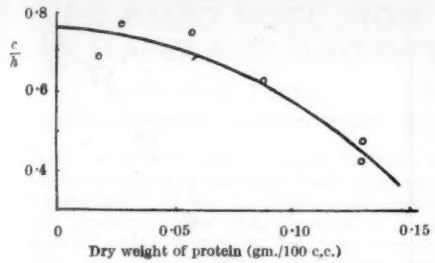

Fig. 2

per one molecule of chlorophyll. In his experiments measurement was made of the total nitrogen and the chlorophyll content of the samples, and the amount of protein was calculated on the assumption that the protein contains, as is usually the case, 16 per cent nitrogen. As we have shown, however, the nitrogen content in the chlorophyll-lipoprotein is only 8·5 per cent. If we apply this figure to Smith's data, the chlorophyll-protein from *Spinacia* and *Aspidistra* leaves must have contained 9 parts of chlorophyll per 100 parts of protein, or 2 molecules of chlorophyll per 20,000 gm. of protein, a value which is in agreement with our findings.

When dissolved in picoline-water, the crystallized substance shows an absorption spectrum, as shown in Fig. 2, in which also the spectrum shown by the original grana suspension (in water) is given for comparison. The absorption maxima are situated at the following wave-lengths: grana, 435, 465, 678 mμ; chlorophyll-lipoprotein, 430, 670 mμ. The absorption at 465 mμ shown by the grana suspension is due to carotenoids which are lacking in the chlorophyll-lipoprotein.

The crystallized substance is soluble in 50–55 per cent aqueous solution of pyridine or α-picoline, but not in water or phosphate buffer of *p*H 7·0. On addition of acetone or ethyl-alcohol, the crystals give colourless precipitates, leaving the dialysable green colour of chlorophyll in the solution. The precipitates formed cannot be redissolved in picoline–water. On addition of lead acetate or on boiling in the presence of salts (ammonium sulphate or phosphate buffer), the solution of the crystal gives green precipitates

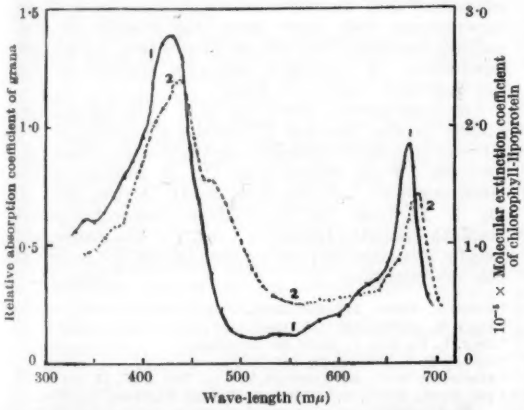

Fig. 3. (1) Molecular extinction coefficient of chlorophyll-lipoprotein (in picoline–water). (2) Relative absorption coefficient of grana suspension (in water)

which also cannot be redissolved in picoline–water. It should be added that, in the experiments so far performed, we have not been able to show that the substance has any biochemical activity, such as that causing Hill's reaction in the presence of suitable hydrogen acceptor.

This work was carried out as a part of the programme directed by Prof. Hiroshi Tamiya and supported by the Scientific Research Expenditure of the Ministry of Education. [Aug. 16.

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INDIRECT INACTIVATION OF BACTERIOPHAGE S 13 DURING AND AFTER EXPOSURE TO IONIZING RADIATION

By TIKVAH ALPER

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INVESTIGATIONS on the effect of ionizing radiations on bacteriophage *S* 13, in dilute suspension in an aqueous medium, have made it possible to distinguish between two separate 'indirect' effects: an instantaneous effect, observed when radiation was delivered within a short period, and a persistent effect, which could be demonstrated after the cessation of radiation. It is presumed that the instantaneous effect is due to active radicals, as postulated by Weiss[1], and that the persistent effect is due in part to hydrogen peroxide produced, and in part to a toxic substance, probably organic peroxide, formed in the interaction between radicals and the debris associated with the bacteriophage preparation.

The following facts were reported, briefly, in a previous communication[2]. (1) When dilute phage suspensions were irradiated at 140 r./min., the rate of inactivation increased with increasing dose, whereas monotopic action[3] due to radicals alone should have given exponential survival curves, that is, inactivation at a constant rate. (2) Exponential inactivation of the phage occurred when hydrogen peroxide was added in amounts comparable with those produced by the radiation doses used. (3) At dose-rates of 140 r./min., and lower, there was a temperature effect of radiation, the rate of inactivation being greater at higher temperatures.

Additional experiments have now been carried out. It was found that the rate of inactivation by hydrogen peroxide depended on: (*a*) the concentration of hydrogen peroxide, (*b*) the concentration of the suspension, and (*c*) the temperature of the suspension.

The amount of hydrogen peroxide formed in the dilute phage suspensions appeared not to differ significantly from the amount formed in aerated water by the same doses of radiation. The method of measurement used was the oxidation of iodide to iodine in the presence of starch[4]. While the oxidizing agent in the water was presumably solely hydrogen peroxide, the possibility exists that the interaction of active radicals with organic material in the irradiated phage preparations produced organic peroxides which oxidized the iodide.

A delayed effect of radiation was found when sampling the phage was continued after the cessation of radiation. This delayed inactivation proceeded exponentially, the rate depending on the dose delivered (Fig. 1). In every case, the rate of inactivation was greater than that found as a result of adding to phage suspensions the amount of hydrogen peroxide which would have been produced by the radiation.

As the irradiation experiments at 140 r./min. took an hour or longer to complete, it was thought that the non-exponential nature of the survival curves might be due to the gradual building up of peroxide in the suspensions, the period of the experiments being sufficiently long for the toxic effects to be in a large measure responsible for the inactivation. It was hoped that persistent effects could be avoided by the use of much higher dose-rates, so that the total time of irradiation was short compared with that necessary for inactivation of the phage by the amount of peroxide produced. It was possible to irradiate at 3,600 r./min. by means of a 'Maximar 100' beryllium-window X-ray tube, the suspensions being irradiated without filtration near the window of the tube. This dose-rate was the average through the suspension, which was thoroughly mixed before each sampling. The survival of phage irradiated at this dose-rate was exponential with dose for all phage concentrations. There is no reason for supposing, therefore, that the action of the active radicals on the phage is other than monotopic.

When phage was irradiated at a low dose-rate (6 r./min.) in the presence of catalase, the survival curve was found to be exponential. Phage suspensions containing no catalase, or the same amount of catalase previously inactivated by heat, showed much higher inactivation-rates, which increased as irradiation proceeded. It would appear that the active catalase destroyed the peroxides as they were formed, so that no gradual build-up of toxic substances could take place.

The variation of inactivation dose (37 per cent dose) with solid content of the phage suspension (Fig. 2) was found to follow the pattern established by the work of Friedewald and Anderson[5] for rabbit papilloma virus, and Lea, Smith, Holmes and Markham[6] for tobacco mosaic virus. The initial constancy of inactivation-dose is well defined, for concentrations up to 10^{-4} gm. protein/ml., or about 5×10^{-10} *M* of the phage and its associated bacterial debris. It can be assumed, therefore, that for concentrations lower than this the recombination of radicals plays the greatest part in their elimination. The fact that inactivation dose is constant over a range of low

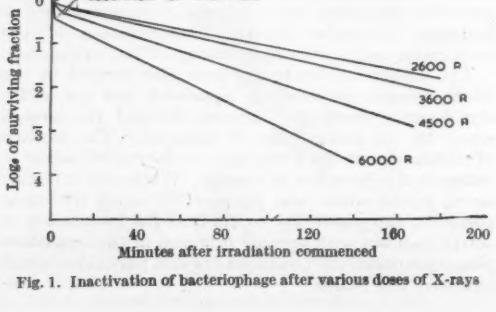

Fig. 1. Inactivation of bacteriophage after various doses of X-rays

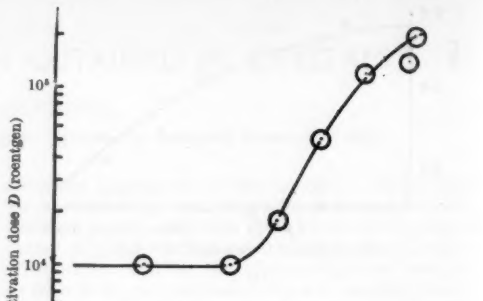

Fig. 2. Dilution curve. X-irradiation at 3,600 r./min.

concentrations leads to the finding that the ionic yield is directly proportional to concentration, in agreement with the theory set out by Dainton[7].

In the earlier communication[2], experiments were described in which the suspending medium was irradiated with doses of 10^5 roentgens or more before the phage was added, and further irradiation given at 140 r./min. The survival curves were found to be exponential, in contrast with those obtained at the same dose-rate without pre-irradiation of the suspending buffer solution. It was at that time assumed that the inactivation in pre-irradiated buffer was due mainly to the action of the hydrogen peroxide already formed in the buffer before the phage was added. Further investigation has shown that this explanation is not correct, since the inactivation of phage suspended in pre-irradiated buffer, and then further irradiated, was compared with the inactivation of similar preparations not further irradiated. The difference in inactivation-rates was very much greater than could be accounted for by irradiation at 140 r./min. acting in the same way as on phage preparations not pre-irradiated. It has recently been suggested[8] that the rapid inactivation found in these experiments may have been due mainly to free radicals resulting from the decomposition, by further irradiation, of hydrogen peroxide formed in the pre-irradiated buffer solution.

The experiments described here were carried out mainly in the National Physical Laboratory, South African Council for Scientific and Industrial Research, Pretoria. I am indebted to Dr. M. Sterne, of the Onderstepoort Laboratories, South Africa, and to Dr. L. H. Gray, of the Medical Research Council Radiotherapeutic Research Unit, for assistance and helpful criticism and advice throughout the course of the investigation. [Sept. 18.

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EXCESS RADIO NOISE FROM SOLAR FLARES AND SUNSPOTS

By Dr. R. Q. TWISS

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SEVERAL writers[1–4] have suggested that the excess noise radiation associated with solar flares and sunspots may be due to longitudinal plasma oscillations similar to those first observed by Tonks and Langmuir[5] in gas discharge tubes, and a number of possible mechanisms have been outlined by which these oscillations could be amplified and maintained. This theory has been criticized by Ryle[6] on a number of grounds: that longitudinal plasma oscillations are very weakly coupled to the radiation field, that the proposed mechanisms are not plausible (particularly those relying on the presence of mono-energetic electron beams), and that the radiation would be produced at a level in the sun from which it could not escape to outer space.

None of these objections is perhaps insuperable, but taken together their weight is considerable. Accordingly, it seems more profitable to look for mechanisms by which the transverse radiation field itself could be amplified at a level in the sun from which it could escape.

A theory of this kind has been given by Bailey[7], who concluded that the transverse field waves could be amplified in certain frequency bands when being propagated in an ionized medium with a component of drift velocity parallel to the sunspot's magnetic field. However, such amplification can only take place under ideal boundary conditions, which would scarcely be encountered in Nature, while, even if they were, the resulting radiation could not escape from the level at which it was generated[8].

An alternative possibility is suggested by the following idealized model. Consider an ion-neutralized electron beam of infinite cross-section moving between two surfaces of discontinuity. Such a system is potentially unstable for transverse waves, as can be shown by an analysis similar to that given by Pierce[9] for the instability of an electron stream flowing in a wave-guide. One loop of the feedback path is formed by a transverse space-charge wave and the forward-travelling field wave; the other loop is formed by the reverse field wave reflected at the surface of discontinuity.

Even in this ideal case, the existence of a closed feedback path and of an available source of energy (the D.C. kinetic energy of the electrons) is not sufficient to ensure that oscillations will build up; it is also necessary that the attenuation due to electron–ion collisions be small, that the proportion of electromagnetic energy reflected from the boundaries be large and that the ratio of the energy carried by the space-charge wave to that carried by the field wave be not too small. It is not necessary, however, that the space-charge wave be amplified or that the electrons be accelerated longitudinally as they cross the interaction space; though either effect would increase the probability of instability.

In Nature, one would not find well-defined surfaces of discontinuity. However, for instability to be possible, it is sufficient that there be regions in which the characteristic impedance of the medium changes appreciably within a wave-length, when appreciable reflexion will occur. It is also more realistic to consider a model where the electron beam is replaced by a thermal plasma moving with a drift velocity less than the mean thermal velocity. In this case also instability is possible, and though the necessary conditions are stringent, they might be met both in solar flares and in sunspots just above those levels where the dielectric constant of the medium is nearly zero. Martyn[2] earlier suggested that plasma oscillations might be excited at those levels, though for different reasons from those given here.

It is true that the attenuation due to electron – ion collisions is a maximum in the neighbourhood of the critical levels in the sun where the dielectric constant is nearly zero. However, for levels in the corona this attenuation is so small that, by itself, it would not prevent instability around a feedback path a few hundred metres in length. Thus, according to Smerd[10], the collision frequency is only ~ 4 c./sec. at a height where the plasma frequency is ~ 100 Mc./sec. Allowing for the fact that the average value of the plasma frequency changes with height at ~ 1 cycle per metre, the attenuation over a 1-km. path is only 4×10^{-2} decibels.

Radiation cannot penetrate below the critical level where the propagation constant is imaginary, so this level provides one of the two reflecting regions needed by the present theory. The existence of a second partially reflecting region is more hypothetical, but the characteristic impedance of the field waves is very high near the critical levels, so that quite a small local variation in the space-charge density or D.C. magnetic field will produce an appreciable change in this impedance. Thus at 1 km. above the critical level for 100 Mc./sec., a change of 0·1 per cent in the average space-charge density would change the characteristic impedance of the field wave by a factor of 10 in a medium with negligible drift velocity. Furthermore, because the field wave-length near the critical level is very long, such a variation could take place over a distance containing an appreciable number of free wave-lengths, that is, over several tens of metres, and still produce an appreciable reflexion. This is in direct contrast with what is required in the theories based on longitudinal plasma oscillations; for there, if appreciable energy is to be radiated, it is necessary that the characteristic impedance of the space-charge wave be changed appreciably within a distance of the order of a space-charge wave-length, that is, of a few centimetres. Since the impedance of this wave does not depend critically on the space-charge density, an appreciable change in the latter is needed to produce an appreciable change in the former.

Any non-thermal explanation for the excess solar noise requires the presence of a source of non-thermal energy, and the drift velocity required by the present theory is a simpler mechanism than the multiple beam or slipping stream mechanisms required by the 'longitudinal' theories.

On the above theory one might expect that instability in a sunspot could take place either in the ordinary or in the extraordinary modes. In large sunspots, however, one would expect the latter mode to predominate, especially at higher frequencies, since then the critical level for the ordinary mode lies deep in the chromosphere where the collision frequency, and hence the attenuation, is high.

Despite the very large effective black-body temperature T associated with large solar bursts, which may reach a maximum[11] of 10^{13} °K., the average energy produced per cubic metre is very small. The radiation from a burst is normally concentrated in a

solid angle of ~ 1 sterradian, so that the flow of power in band-width $d\nu$ across unit area is $\sim \alpha k T(\nu^2/c^2)d\nu$—where α, a factor depending on the attenuation due to scattering between the critical level and outer space, is of the order of 10. Since the critical frequency changes with height at ~ 1 cycle/metre when $\nu \sim 100$ Mc./sec., the average electromagnetic power generated per metre³ in the largest bursts is $\sim 10^{-3}$ ergs/sec. The thermal kinetic energy of the medium at this level is $\sim 4 \times 10^4$ ergs/m.³, so that a drift velocity 10^{-2} that of the mean thermal velocity would transport 4×10^3 times more energy across unit surface in unit time than is radiated from unit volume. [Aug. 16.

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SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING AT LIVERPOOL

BY the kind invitation of the Council of the University of Liverpool, the annual meeting for 1952 of the Science Masters' Association was held there during January 2–5.

The meeting opened with a presidential address from the vice-chancellor of the University, Dr. J. F. Mountford, upon the subject of "Speech and Language". Dr. Mountford said that every year the relations between the schools and the universities are growing closer and that in the strengthening of those links the Science Masters' Association has played and continues to play a notable part. Through the *School Science Review*, the Modern Science Memoirs and other publications and reports, the Association has made a positive contribution to the enlightened teaching of science, and no teacher of science in the universities that he had met had not gladly acknowledged the indebtedness which the universities owe to its work in improving the quality and range of achievement of the university freshmen. It is a matter of vital concern to the universities, he said, that the students who come from the schools should not only have acquired a satisfactory body of factual information about scientific subjects, but also that their minds should have been trained in the fundamentals of scientific method and outlook. It is, indeed, a matter in which the Association can take pride that, alongside the improvement in pedagogic techniques for which it has been so largely responsible, it has always taken a wide view of the aims of science teaching and has related its own special interests to that general culture and enlightenment which it is the aim of all educational activities to ensure.

Dr. Mountford said he was happy to be numbered among the presidents of the Association. His own life had been spent in an endeavour to understand, through the medium of their written memorials, the thoughts and civilization of two ancient peoples who had contributed so much to the foundations of Western culture. Words, and ideas they convey, had been his main concern, and the works of the Greek and Latin poets, philosophers, orators and historians had been his laboratory.

For the practical purpose of everyday life, Dr. Mountford said, the average man is in no way handicapped by his pragmatic acceptance of language as he finds it; he no more needs a theory of language in order to communicate verbally with his fellows than he needs a knowledge of physiology and mechanics to be able to walk. Yet for those of a philosophical turn of mind, language cannot be exempt from examination and analysis. Dr. Mountford examined the many factors involved in speech—the many syllables each comprising several speech sounds all demanding separate movements of the vocal organs and yet all adjusted in a complicated pattern within an exceptionally brief space of time. Upon this are superimposed breath modifications, and changes in the oral cavity, together with stresses placed with uncanny accuracy by native speakers but providing serious pitfalls for the foreigner; and finally, there is superimposed upon all these intricacies the general tune or intonation, the effective mastery of which is often the most difficult of the operations involved in the learning of a foreign language. It is only possible to suggest the stage in man's development when language emerged; but Prof. R. J. Pumphrey, of the University of Liverpool, has recently argued with some force that the likely time is the Aurignacian period of the Upper Palæolithic age, some 100,000 years ago.

Dr. Mountford said that there can be no doubt that the development of the human mind has been closely bound up with the growth of our power over language. This is particularly evident in the case of the abstract concepts which have become crystallized in linguistic symbols and have become the units by means of which we erect larger constructions of thought. It is interesting to note that this complex relationship between our mental processes has been seized upon as the basis of a modern literary technique. James Joyce, for example, in a confused sequence of words, tries to capture the misty borderland which lies between inchoate thought and literary expression; no logical analysis will provide the true interpretation of a passage such as this: "By earth and the cloudy but I badly want a brandnew bankside, bedamp and I do, and a plumper at that!"

Many words are emotionally neutral, as are the technical terms of the sciences; but others possess a penumbra of associations. In the laboratory 'water' is a label for a particular combination of elements, and it has no emotive function or significance. But when it is used by an author in describing a shipwreck or an adventure in the desert, the same word may be intended to arouse feelings of terror and of pity. It is in poetry that we find the most striking use of emotive language; but in science it is far different. Science is concerned with measurements rather than with values, and the findings of science do not make allowances for penumbras of meaning; if they did they would be of little worth. In the language of science, symbolism has gone far, and the language of formulæ has become a very potent extension of man's power of thought, so that they have become more and more difficult to recast into the verbal forms of normal language. In achieving advances in human thought, culture and comfort, language has been one of our most powerful instruments; and the study of language can never fail to

be an absorbing topic for anyone who is interested in the fascinating panorama of human progress.

In addition to the presidential address, lectures were given by six members of the academic staff of the University. Prof. G. Stephenson conducted a party over the new Civic Design Building. This was a most interesting experience as it allowed the visitors to understand the principles which are governing the many unusual features incorporated into the building. In the lecture which followed, Prof. Stephenson showed some examples of actual and projected planning from the early seventeenth century onwards, and followed this by discussing the problems facing those who are dealing with the re development of large cities at the present time, from which it was evident that those who would rationalize the lay-out of Greater London have an almost impossible task.

Prof. R. M. Gordon welcomed the Association to the "oldest School of Tropical Medicine in the world". He said that during the fifty-two years of its existence, the School has been called upon to investigate many problems of tropical medicine. In most cases it proved to be the non-medical biologist who led the way which later the physician followed. Hence the necessity for the combination of medicine and biology in the field of research in tropical medicine. Prof. Gordon then described two investigations being carried out at the present time in Africa, in which he is being helped by Prof. T. H. Davey, who later in the morning showed a film on "Ngana" (trypanosomiasis infection of animals in Africa).

The first investigation is being conducted in the Gezira, the vast cotton-growing area of the Anglo-Egyptian Sudan. Last year a world record crop was almost lost because of labour shortage attributed to the ill-health caused by schistosomiasis or bilharziasis. This worm infection invades the bladder and causes hæmorrhage; the eggs of the worm pass out in the urine, and if they reach water they hatch out and undergo further development in a freshwater snail. After some six weeks development the larva escapes back into the water and in its new form is capable of boring through the unbroken skin of anyone coming in contact with the water. The problems involved are so many that it was recommended that a research team consisting of a medical man and a freshwater ecologist should be appointed to co-operate with the large and highly skilled team of botanists and chemists now serving with the Gezira Cotton Scheme. It is pleasing to record that the Sudan Government has agreed to the appointment of such a team.

The second investigation is being carried out in the Cameroons. This area, though free from malaria and, on the whole, very healthy, is subject to loiasis, due to the loa-loa worm. The female worm lives in the human body and produces larvæ which get into the blood stream, from which they are taken up by the extremely common biting fly, *Chrysops*, known locally as the red fly. These biting flies then transfer the larvæ to another human subject, where the life-cycle is continued, producing much invaliding and suffering among both the native and the European populations. As the flies live in the forest canopy some 60 ft. above ground level and feed on the blood of monkeys, it seems that humans are only attacked on sight. Thus the forest canopy could be cleared back from human habitations provided sufficient undergrowth remained to keep the human population invisible to the flies. With insufficient knowledge, widespread control might be dangerous. Hence the need for the combined efforts of medical men and biologists to solve this problem.

Prof. C. E. H. Bawn startled his audience by saying that all chemical reactions are oxidations and reductions, and that the uptake of oxygen is one of the fundamental activities both of Nature and of chemistry. He described in detail some of the work carried out in the Chemistry Department of the University and showed how many reactions depend upon the formation of free radicals and of the derivatives of hydrogen peroxide.

Dr. J. D. Craggs thrilled his audience with lightning displays. Dr. H. D. Parbrook surveyed the whole field of acoustics and indicated that the classical work of Sabine is now considered inadequate to describe the acoustic characteristics of a building, the simplest form of which demands equations involving 65 functions.

Dr. J. W. Jones described and showed a film of his original work on the spawning of salmon. This was a brilliant lecture.

The customary exhibitions were held, including one of apparatus devised by members. This, as usual, showed many ingenious devices all of which, this year, were of use for the younger pupils. In addition, the Nuclear Physics Department of the University was open for inspection, showing the giant cyclotron under construction. The Engineering Department gave a demonstration and the Physics Department showed a wide range of experiments which was greatly appreciated.

Nearly thirty teaching films were shown, and some of the senior pupils of the local grammar schools were invited to see them.

The Mersey Docks and Harbour Board invited a party to see its installations, and many firms in the neighbourhood conducted parties over their works.

On January 3, the Lord Mayor and the Lady Mayoress of Liverpool gave a civic welcome in the Town Hall to the Association. This was a most brilliant occasion, in the magnificent setting which the old Georgian suite of rooms permits.

Finally, the Vice-Chancellor invited the Association to a reception in the University. This was a charming event which included a recital in the delightful Arts Theatre.

Discussions, both formal and informal, filled the remaining time, and one can be assured that the teaching of science in all parts of Britain will have been stimulated by the excellence of this annual gathering of the Science Masters' Association.

WILLIAM G. RHODES

FURTHER EDUCATION AND THE NEEDS OF GREAT BRITAIN

IN his Will Harvey Memorial Lecture on "The Place of Further Education in the Public Services", given in the City Training College, Sheffield, on September 29, Sir Harold Hartley suggested that further education should be conceived not as a compound of vocational training with education for leisure but as education for co-operation and efficiency, for an understanding of the issues we face to-day, and for the defence of individual freedom and justice. In Great Britain national service in the Armed Forces has presented a new opportunity and fresh responsibilities, and it is a challenge to the Services so to use those vital

years in a young man's life that he will look back on them with pride and affection in the same sort of way that many men do to their undergraduate days.

Much is already being done in private industry, but Sir Harold thinks that the biggest problems facing the nationalized industries in Britain are those of human relations, and to these the continuous process of further education at all levels is the answer. The main objective of such education must be the improvement of human relations, the establishment of mutual confidence and community of interest and a realization of the difficulties which Britain has to face and their inevitable and apparently frustrating consequences. In no other way is it possible to hope to escape from the misunderstandings and mistakes which ultimately affect everyone adversely.

Some day it must be realized that the inescapable effect of industrial disputes and restrictive practices is to lower the standard of living. Sir Harold reviewed briefly what is already being done in Great Britain to meet this need in the nationalized industries and the Civil Service, and he quoted with approval Sir Fred Clarke's view that the essence of adult education lies in its appeal to the adult student as a commitment to action. Such a student wants to know what he is to do, both as a person and as a citizen, and the objective should therefore be, not so much formulated knowledge, but rather a rational interpretation of experience.

In bringing the Lecture to a conclusion, Sir Harold insisted that the two problems are interdependent, one of increased productivity and thus retaining for Great Britain its place in the world to-day and its standards of living and way of life, and the other of curing the maladjustments and lack of mutual confidence in a rapidly changing society. The best hope of securing real community of interest and giving individual satisfaction lies in joint consultation and recognition of the contribution that each individual can make and his responsibility to do so. The new range of responsibilities that joint consultation implies can only be met by opening a new chapter in education in Great Britain, both for management and for the trade unions. This is the most urgent task for further education and its immediate opportunity.

TRAINING OF SUPERVISORS AND OF OPERATIVES IN INDUSTRY

TAKEN together, the two Productivity Team reports*, on the training of supervisors and of operatives respectively, form a counterpart to the report on trade schools of the Continent issued as a result of a visit twenty years ago by two Board of Education inspectors, A. Abbott and J. E. Dalton. Indeed, one of their most interesting features is the extent to which the recommendations of the Productivity Teams reiterate what was urged by Mr. Abbott in his subsequent book "Education for Industry and Commerce in England". There we find the same stress laid on the bearing of technical education on industrial efficiency, economic recovery and the maintenance of standards of living; thus early was the inefficiency of some industries attributed to their failure to utilize the scientific knowledge available to them. That failure was, it is true, in Mr. Abbott's view, due to those industries not employing enough men with the necessary wide and thorough scientific training, but by and large there is a disturbing similarity between the reflexions provoked twenty years ago by an examination of technical education on the Continent in comparison with that in Great Britain and the impressions derived by the Productivity Teams in their examination of the American scene last year.

There are differences and changes, especially in detail, but the generalization is broadly true, and it does not augur well for the industrial and economic future of Britain that so little advance should be recorded in two decades. When all allowance is made for the differences in background, and between the American and the British way of life, both these reports leave the impression that the main difference between the American scene and the British scene is psychological. In all types of training, the eagerness of the individual to be trained is a basic assumption in the United States: the individual readily accepts a way of life in which his prosperity is directly proportional to his own efforts and ability, and there is a stimulating atmosphere of vitality which allows no practices to be unalterably established. New practices are constantly being evolved and old ones are scrapped without regret as soon as new and better ones appear.

Another significant passage in the report on the training of operatives is that referring to status in American industry. It appears that there is a steady movement towards a position where all those in supervisory posts will have college or university degrees, all journeymen and apprentices will be high-school graduates and most other employees will have had high-school education up to the age of seventeen or eighteen. "If we remember, too, that many, perhaps most, of the best pupils from the high schools enter industry (most of our best pupils enter the professions), we may ponder on the profound effect this trend is having and will continue to have on the efficiency of American industry." Much of the development, particularly in the training of teachers, has been recent: in fifty years the high-school population has increased from about one-third of a million to more than six millions, and is now about 25 per cent of the total enrolment instead of 2·5 per cent. Any country might well be proud of what has been accomplished, and the Team records further its considered opinion that educational policy in the United States is being so shaped that these achievements will be consolidated and progress maintained throughout the second half of the century.

The report notes that the American approach to vocational training is marked by a refreshing willingness to experiment and by a freedom from tradition and prejudice. Both management and labour recognize the urgency of the current training problem in industry; employers regard training as an investment, and unions are willing to vary regulations as circumstances demand. The value of training schemes, however, depends not only on the degree of such goodwill but also on the degree in which employers and unions succeed in working together; but the fairly free general movement from lower to higher paid jobs encourages the worker to take advantage of the training offered.

* Productivity Reports. Training of Operatives. Report of one of four Specialist Teams which visited the United States of America in 1951 to study Problems of Training for Industry. Pp. xii+52. 3*s.* Training of Supervisors. Report of a visit to the U.S.A. in 1951 of a Specialist Team to study Supervisor Training and Selection. Pp. viii+56. 2*s.* 6*d.* (London and New York: Anglo-American Council on Productivity, 1951.)

The Team was appointed by the Anglo-American Council on Productivity "to study the selection and training for and within industry of operatives by trade schools and other institutions and by industries, both as semi-skilled production workers and as apprentices or journeymen in their skilled trades and in the utility services. Also the further training and re-training and regrading of these workers to become more skilled and productive". The chief points in American practice which the Team recommends should be followed in Great Britain, having regard to differing background and differences in way of life, are in regard to a higher school-leaving age, the administration of vocational training by practical people, the age and duration of apprenticeship, the promotion of closer co-operation between educational establishments and industries, the improvement of training within industry and the spotting of talent (but by British rather than American methods) and the study of principles of training used at the Kelly Air Base with the view of their application in industry in Britain, particularly in achieving greater adaptability of the individual worker. On the other hand, it believes that the United States will eventually find it desirable to adopt something on the lines of the British system of National Service in place of the rather arbitrary system at present operated; and, apart from requiring training of instructors in practical subjects to take courses in teaching methods, the Team does not consider we in Britain have much to learn from the organization and administration of vocational schools and institutes in America.

Specifically the Team considers it likely that an increasing proportion of young people in the United Kingdom will in the future continue their full-time education until they are seventeen or eighteen, and most of the Team believed this tendency can only operate to the advantage of industry and of the individual, provided the instruction in the schools is realistic, and anything which can be done to accelerate it should be encouraged. With regard to apprenticeship, it urges strongly very careful re-examination by all industries of the question of age-limits and periods of training, particularly now that compulsory National Service has become a permanent feature of British life. The American system, in which the upper age limit of prospective apprentices is almost completely disregarded, is more flexible and suited to modern conditions than the rigid practice in Britain of restricting the age of entry to sixteen. It also suggests that the American practice of giving credits to apprentices for work at vocational schools should be investigated by more industries, as well as the system of making the indenture between the apprentice and the local joint apprenticeship committee. Some trade unions in Britain might, with advantage to employer and employed, insist upon higher standards for admission to the ranks of their skilled workers.

The Team which investigated the status and duties of American industrial supervisors and the methods used for selecting and training them was impressed with the way in which supervisor selection and training is treated as a matter of high policy affecting all members of management, from the company president down to foreman. The difference between the advisory or staff function and the executive or line responsibility is clearly understood, and authority is clearly defined and widely delegated. Although the American foreman occupies the lowest rung of the supervisory ladder, he is regarded as part of the management and is seen as such by his operatives. He is usually intelligent, ambitious, production-minded and cost-conscious, and his management status is emphasized by full management privileges and constant consultation with him on plant policy. Stress is laid on his understanding that success in handling the men or women he controls is the true measure of his practical efficiency. An adequate standard of technical ability is taken for granted.

As regards selection, the Team found the main lesson of American practice not so much in details of procedures as in the general emphasis on systematic selection and the open-minded and innovating attitude. In range and thoroughness it considers that supervisor training in the United States surpasses corresponding activity in Britain. In the typical large company, the first key principle is that training of supervisors should be done mainly within the company in terms of its own policy and practice rather than by an outside agency. The second principle is that all members of the line organization are responsible for applying supervisor training; it is a tool of management in normal operations. Higher management is reluctant to impose formal training, preferring that the training staff should consult with factory and office managers in assessing training needs. Training programmes are then initiated and are continuous and progressive in character, based on weekly or monthly sessions during working hours. Both individual and group methods are used, though a combination is preferred. The former are the most effective but are also the most difficult to adopt. The success of group methods depends largely on the skilled use of conference techniques, as does the success of the 'case studies' which are being effectively developed as a means of instruction. In all supervisor training schemes the approach is practical, but training in 'human relations' predominates. Other subjects commonly included in training programmes are work study, effective speech and report writing, costing and budgetary control and conference leadership; but the Team is uncertain as to the merits of including courses on economics and the like. There appeared to be some danger of excessive reliance on visual aids. All the large companies visited were spending substantial sums on supervisory training and obviously believed in its beneficial effect on productive efficiency. Little supervisor training, as such, is available through universities and colleges of technology in the United States, but some important research and survey work is undertaken by such institutions, and the Team emphasizes the need for further research in the field of supervision. It recommends that the attention of appropriate educational and professional institutions should be directed to the study of training methods applicable in industry.

Besides this it emphasizes, in conclusion, the contribution which could be made to productivity by careful selection and training of supervisors and the need for well-informed and sustained support of such development by the highest level of management. A systematic approach to the selection of supervisors at all levels should be widely adopted and all supervisors should be regarded as responsible members of the management team. More effective provision of advice and of training courses for line-management trainers is required to meet the requirements of smaller firms, and most points noted above are singled out as worthy of serious consideration in British industry.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mode of Blocking of Axonal Activity by Curare and Inhibitors of Acetylcholinesterase

Micro-injection of certain strategic substances into the axon of the squid (*Loligo pealii*) has been carried out in order to study further the correlations between observed electrical activity of the nerve and possible neuro-chemical events. A micro-pipette with a long shaftlet having a lumen at the tip not more than 5 μ in diameter can be readily inserted into the giant axon between a pair of external electrodes. At will, it can be placed at the site of one electrode. These manœuvres can be accomplished without damage to excitation of, or propagation in, the fibre. The present communication is confined to reporting the blocking action of eserine and prostigmine, stilbamidine and curare, injected in aqueous solutions (usually containing 0·2 per cent phenol red, which colours the injection site an orange-yellow). Total fluid injected varied from about 10^{-4} mm.^{3} to 10 or 12 mm.^{3}, usually, however, being of the order of 0·5–5 mm.^{3}.

Although eserine and prostigmine are both powerful inhibitors of acetylcholinesterase, it is well known that the first, applied externally, blocks axonal activity whereas the second does not[1]. Prostigmine is ineffective because it does not penetrate the permeability barrier of the fibre. The present experiments, however, show that local injection of either substance directly into the axon blocks excitation under the stimulating cathode or propagation of the spike beyond the injection site. 5–10 μgm. of either substance acts within 1–2 sec. About 0·1 μgm. of prostigmine blocks within 10–30 sec. About 1 μgm. of eserine is required to produce a block in the same length of time.

In the group of curare-like compounds, stilbamidine when externally applied blocks axonal activity[2], whereas *d*-tubocurarine does not, the difference again being ascribable to a permeability barrier for the latter. However, injection of either substance into the axon in extremely small amounts causes block. The minimal quantities to act within 10–20 sec. are about 10^{-4} μgm. for stilbamidine and 10^{-3} μgm. for *d*-tubocurarine.

With all four substances, injection of small droplets in the minimal concentrations results in a brief block and recovery, which is to be ascribed to diffusion of the substance along the axon and its consequent dilution at the injection site. Injection of a few cubic millimetres of the carrier fluid alone causes no block, and even when the entire axon is injected with the fluid, axonal activity is maintained for 15 min. or more. The blocking which then takes place is at no time reversible.

Acetylcholine chloride injected in relatively high amounts (1 μgm. and 0·01 μgm.) in a few experiments blocked activity. With these concentrations there was no initial excitatory phase, nor was there observed any alteration in the form of the terminal spike.

The above series of experiments demonstrates that certain substances ordinarily ineffective when applied externally do act in the interior of the axon once the permeability barrier is overcome. Both acetylcholine and curare, furthermore, exert a much more powerful action upon axonal conduction than upon synaptic transmission. It is to be noted that stilbamidine and *d*-tubocurarine, which are relatively weak inhibitors of acetylcholinesterase, exert their action in much smaller concentrations than do the powerful inhibitors eserine and prostigmine. The mode of action of the two groups of substances is therefore probably different. Considerable evidence has recently accumulated to implicate a 'receptor protein' in the axonal membrane upon which acetylcholine liberated in the course of activity exerts its effects. It seems likely that the curare group of substances owe their blocking action to competitive combination with this 'receptor protein'. The present experiments also indicate that acetylcholinesterase cannot itself be the 'receptor protein', as suggested by one of us[3]. A co-ordinated functioning of all three chemical components, acetylcholine, the esterase and the 'receptor protein', is required to effect the propagated electrical activity of the axon.

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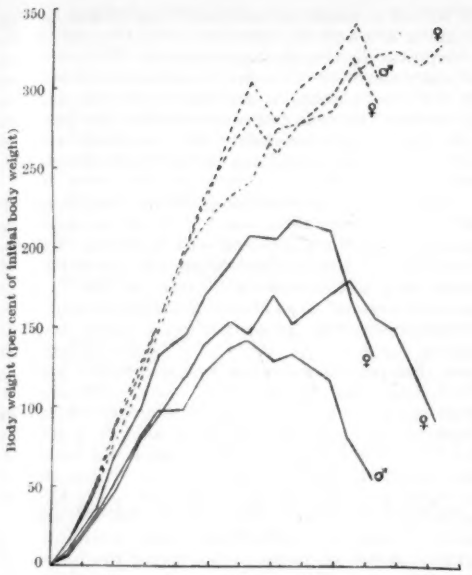
Lethal Retardation of Growth by Electric Shock

It has been shown that electric shock retards regeneration of the corneal epithelium of rabbits[1] in a manner similar to the depression of mitotic activity of the skin epithelium by other forms of shock[2]. Between the cells of various tissues, there seem to be some differences in susceptibility to antimitotic action. This may depend, among other possible causes, on the speed of multiplication of the cells. In order to obtain a first impression of what is going on, it was considered very important to investigate the effect of repeated electric shocks on the weight of growing animals and their organs. The animals (rabbits) were divided into two groups each consisting of six animals of both sexes. Experiments with the first group were started on the eleventh day after birth, with the second group on the eighteenth. In each group three animals served as controls. The animals were treated by electric shock once a day with the exception of Sunday in the same manner as described earlier[1].

With regard to endurance there was a great difference between the two groups. The first group tolerated 25–30 treatments, the second group 44–52 treatments before death occurred. Twice a week the growth of all animals was checked by weighing. The accompanying graph shows the increase of weight as a percentage of the initial body-weight in the



——, Shocked animals; – – – –, controls. All the shocked animals died

second group. The graph demonstrates a striking growth-retarding influence of electric shock. There was also a great difference in the weight of particular organs when compared with the organs of untreated animals of the same age. The exact numbers will be published elsewhere after further investigations have been carried out. The greatest decrease in weight was seen in the thymus. The striking difference in the susceptibility to electric shock between the two groups may be correlated with different stages of maturity, for example, of kidney[3,4] or liver[5,6].

It may be said in conclusion that the growth-retarding influence is very pronounced, especially when we take into account the short period of convulsions and unconsciousness (60 sec. on an average).

The observed inhibition of growth did not depend on a want of food, because the intestines were full at autopsy. Since the number of shocks required to cause death varies only within rather narrow limits, it may be concluded that a humoral factor must also be involved. In the meantime, the growth-inhibiting action of adrenotropic hormone has been observed by several investigators[7,8], but we have not found any reference in the literature to a lethal effect on newborn animals.

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An Independent Synthesis of Phospholipids in the Femur and Tibia of White Rats

IN the course of a general investigation into the influence of vitamin D on the phospholipid metabolism in rats, we found indications of an independent synthesis of the phospholipids in bone marrow in some of our experimental animals. In a number of animals the values of the specific activity (expressed as the percentage of the injected dose per mgm. phosphorus per 100 gm. rat) of the phospholipid fraction isolated from the femur and the tibia within two hours after subcutaneous injection of phosphorus-32 as phosphate exceeded values found for the phospholipid fraction isolated from the plasma. The phenomenon presented itself so often and so clearly that it could not be ascribed to the inaccuracy inherent to the analytical methods used.

Zilversmit *et al.*[1] have shown that the specific activity of a component, before reaching its maximum value, must be smaller than the specific activity of its precursor. Now there are good reasons for assuming that for rats the plasma contains little or no cephalin, and that sphingomyelin accounts for only about 25 per cent of the total phospholipids and takes up phosphorus-32 at a somewhat lower rate than lecithin[2]. In view of the higher values found for the specific activity of the phospholipids isolated from the femur and the tibia, we regarded a renewal of these phosphatides, by exchange with plasma phospholipids only, as rather improbable; and we began an investigation of the possibility of independent phospholipid synthesis in the bone marrow.

Adult white rats (Wistar strain) were narcotized with pentothal and one femur was carefully exposed. Using dental apparatus, a small hole was drilled in the shaft just reaching the cavity, and afterwards 0·01 ml. of an active phosphate solution (about 5 μc.) was injected into the proximal part of the cavity. The hole was then closed with bone wax, the exposed tissue washed rapidly with some lukewarm saline and the incision closed with a few stitches. After 5–60 min. the animals were sacrificed by decapitation. We determined the values of the specific activity of the inorganic and of the phospholipid fraction of the plasma, the liver and of both the treated and the untreated femur.

If an independent synthesis of phospholipids takes place in the femur, then we must expect the value of the specific activity of the injected femur to be considerably higher than those of the other femur and of the plasma. A number of the animals demonstrated this result clearly. However, as a whole, the results were not so clear that final conclusions could be based on these experiments alone. This must be ascribed to the great experimental difficulties of the method used, including the varying influence of narcosis, the difficulty of injecting 0·01 ml. accurately into the cavity of the femur and the possibility of contamination of the surrounding tissue with highly active phosphate. We have therefore tried to confirm our results with the help of *in vitro* experiments, using the technique described by Chaikoff *et al.*[3] for various tissues.

Adult rats weighing about 300 gm. were killed and the femurs and tibias removed. The bones were split and the marrow carefully isolated and brought into a Ringer solution containing phosphorus-32 phosphate. The marrow of one femur and of one tibia was incubated for four hours, after which the activity of the phospholipids was determined in the usual

way. The marrow of the other femur and tibia served as a control; the activity of the phospholipids was determined immediately after the marrow had been put into the radioactive Ringer solution. The results are shown in the accompanying table.

Activity of Phospholipids of Bone Marrow after Incubation in Ringer Solution containing Phosphorus-32 Phosphate

Rat	Weight bone-marrow (wet) (mgm.)	Time of incubation (min.)	Activity of isolated phospholipids (counts/min.)
233 *a*	40	0	1·3
b	35	240	26·2
234 *a*	45	0	5·4
b	50	240	51·6
235 *a*	42	0	6·4
b	51	240	58·3

The results clearly show that, with the method used, contamination of the isolated phospholipids with radioactive inorganic phosphate is only slight. The activities of samples *b* prove beyond doubt that bone marrow is able to synthesize phospholipids *in vitro*. This result, combined with the outcome of the *in vivo* experiments, leads us to believe that an independent synthesis of phospholipids takes place in the bone marrow.

Our thanks are due to Prof. A. H. W. Aten, jun., for much helpful advice. The investigation was made possible by a grant from the Netherlands Organization for Pure Research.

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Failure of Phosphorus-32 to Exchange with Organic Phosphorus Compounds

When radioactive phosphate is used in biological experiments, the interpretation of the results depends upon the assumption that the labelled inorganic phosphate does not exchange with the phosphate of organic esters except via metabolic reactions. Evidence to support this assumption is limited. Hevesy and Aten[1] were satisfied that phosphorus-32 did not exchange with the Embden ester (hexose-6-phosphate), and apparently inorganic phosphate does not exchange with glycerophosphoric acid[2]. Studies on human erythrocytes in this laboratory[3] have made it desirable to determine whether phosphorus-32 is able to enter certain other acid-soluble phosphate esters by simple exchange.

The experiments were made as similar as possible to those on blood. A volume of 10 ml. was made to contain 200 μgm. inorganic phosphorus as $Na_2PO_4.12H_2O$, including an amount of phosphorus-32 sufficient to give approximately 10^4 counts per minute per ml., plus one of the phosphate esters in a concentration approximately equal to that found in 10 ml. human blood. The *p*H was adjusted to about 8. Flasks containing the mixtures were shaken for three hours on a Warburg apparatus at a rate of about 70 per min. The temperature was maintained at 37·0° ± 0·02° C. At the end of the incubation period, 15 ml. of a magnesia mixture[4] was added and the mixture allowed to stand at 2° C. for 48 hr. to precipitate the inorganic phosphorus. The precipitate of magnesium ammonium phosphate was removed by filtration through a sintered glass disk, dissolved in dilute nitric acid and aliquots taken for precipitation as phosphomolybdate for counting[4] and for colorimetric determination by the method of Fiske and SubbaRow[5].

In each case the remaining filtrate was aerated at 60° C. to remove ammonia. Further treatment depended upon the phosphate ester involved. Glucose-1-phosphate (Bios Laboratories) was made 1 *N* with nitric acid and heated for 20 min. at 100° C. before aliquots were taken as above. Adenylic acid (Schwarz Laboratories) was made 1 *N* with nitric acid and heated for 5 hr. at 100° C. 2,3-Diphosphoglyceric acid (the pentabarium salt was generously given by Prof. Erich Baer, University of Toronto) was acidified with nitric acid, evaporated to a small volume and digested with concentrated nitric acid on a hot plate for 3 hr. Then 3 ml. perchloric acid was added and the sample heated to fuming point. Adenosine triphosphate (Pabst Laboratories) was made 1 *N* with nitric acid, heated for 20 min. at 100° C., and the labile phosphorus thus released was precipitated by adding excess ammonia and allowing the mixture to stand 48 hr. at 2° C. This was removed by filtration and the filtrate digested with concentrated nitric acid on a hot plate for 4 hr. to release the stable phosphorus.

Phosphorus ester mixed with inorg. phosphorus	Amounts added (μgm.)		Amounts recovered (μgm.)		^{32}P recovered (as percentage of ^{32}P added)	
	Inorg. P	Org. P	Inorg. P	Org. P	Inorg. P	Org. P
Glucose-1-phosphate	200	140	209	134	95·2	0·1
Adenylic acid	200	90	210	112	97·1	0·1
2,3-Diphosphoglyceric acid	200	520	225	325	97·7	0·2
Adenosine triphosphate	200	377* 189†	216	297* 167†	97·3	0·4* 0†

* Labile phosphorus of adenosine triphosphate.
† Stable phosphorus of adenosine triphosphate.

The results of duplicate determinations agreed very closely and the averages are given in the accompanying table. In most cases good recoveries of the substances in the mixtures were obtained. An exception is 2,3-diphosphoglyceric acid, which is known to be extremely stable and is apparently not entirely hydrolysed by the treatment described above, since only about 62 per cent of the phosphorus content was recovered. It will also be seen that the ratio of labile to stable phosphorus in adenosine triphosphate fell during the incubation from the original 2·0 to 1·8, indicating that at the end of the incubation period only 80 per cent of the original adenosine triphosphate remained and 20 per cent had broken down to adenosine diphosphate and inorganic phosphate. Of the added phosphorus-32, 95–98 per cent was recovered as inorganic phosphate, while the greatest percentage appearing in an organic fraction was 0·4 per cent recovered with the labile phosphorus of adenosine triphosphate. This is considered to be very close to the limits of error in the methods used. A supplementary experiment in which trichloroacetic acid was added after the incubation period (reducing the *p*H to less than 1·0) gave essentially the same results.

It is concluded that under the conditions described there is no simple exchange between inorganic phosphate and the phosphate groups of either glucose-1-phosphate, adenylic acid, 2,3-diphosphoglyceric acid or adenosine triphosphate. Incorporation of phosphorus-32 into these compounds in experiments with tissue in these circumstances must be considered to be a result of metabolic reactions.

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Sedimentation and Diffusion of Soluble Fibroin

Aqueous solutions of fibroin were prepared by dissolving degummed silk in cupri-ethylenediamine, neutralizing, and dialysing against distilled water. In order to obtain solutions as examined by Coleman and Howitt[1], part of the fibroin was precipitated by adding hydrochloric acid, and the part remaining in solution was neutralized and further dialysed.

Measurements of sedimentation velocity on this solution, brought to 0·2 *M* in potassium chloride in order to eliminate charge effects, were made in an ultracentrifuge, using a field of 150,000 *g* and observing by the Lamm scale method. Diffusion measurements, with 0·2 *M* potassium chloride throughout the system, were made in a Neurath diffusion cell[2] at 20° C., also with the scale method; diffusion constants were evaluated by the area – height method. Since soluble fibroin is unstable, freshly-prepared solutions were used.

The sedimentation peak remained single in all the runs, and the diffusion curve was always symmetrical, sometimes being slightly leptokurtic compared with a Gaussian curve. For different preparations of soluble fibroin at the same concentration we often found widely differing diffusion constants; there were smaller differences among the sedimentation constants. Thus the sedimentation constant s varied between 2·3 and 2·8 ($\times 10^{-13}$ sec.) at a concentration of 5 gm./litre; and the diffusion constant D_A, measured over a range of concentration from 1·2 to 7·8 gm./litre, varied (at random with the concentration) between 3·1 and 1·6 ($\times 10^{-7}$ cm.^{2} sec.$^{-1}$) in different preparations. From a total of five sedimentation runs and eleven diffusion experiments on twelve fibroin preparations, the average results were:

$$s = 2{\cdot}6 \times 10^{-13} \text{ and } D_A = 2{\cdot}5 \times 10^{-7} \text{ at } 20^\circ \text{ C.}$$

We did not find the suppression of widening of the sedimentation peak that is associated with an increase of sedimentation constant on dilution; therefore sedimentation constant probably does not vary much with the concentration in any one preparation of soluble fibroin. Similarly, the symmetry of the diffusion curve suggests that, for any one preparation, Fick's law is valid. We may therefore calculate molecular weights from these results without gross error. From the apparent specific volume of degummed silk in water (0·704), we assume the partial specific volume V is 0·7.

The extremes of molecular weight, corresponding to the lowest sedimentation constant and the highest value of D_A (and conversely), are 60,000 and 150,000. The average molecular weight, corresponding to the average sedimentation constant and the average D_A, is 84,000. These are all well above the molecular weight of 33,000 reported by Coleman and Howitt for soluble fibroin prepared in the same way. The great variation of molecular weight that we find between different preparations of soluble fibroin shows that a more precise control is necessary either in dissolving the silk (where degradation may occur), or in the dialysis, or in the partial precipitation by hydrochloric acid. (This precipitation may conceivably be a molecular-weight fractionation.) Until this control is attained, we have clearly no knowledge of any unique 'molecular weight of fibroin'.

The average sedimentation constant and D_A correspond to a frictional ratio (f/f_0) of 3. The fibroin molecule in these solutions is therefore not a compact unhydrated sphere. Assuming no hydration, we could fit the average experimental results by a compact rigid ellipsoid or other non-spherical shape, or by a random coil[3] of great flexibility. The experimental results, however, do not justify a detailed calculation.

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Reversible Photo-Bleaching of Chlorophyll in Rigid Solvents

Chlorophyll solutions undergo a reversible 'bleaching' when strongly irradiated[1,2]. Possible explanations for the effect have postulated the formation of a long-lived excited state of the dye followed by a dismutation reaction between excited and normal dye molecules[2,3], or a redox reaction between the excited dye and solvent[4]. To date, work on the photo-bleaching reaction has been carried out at room temperature in fluid solvents, and has dealt with changes in the red absorption band.

We have obtained a rough measurement of the reversible spectral changes produced by irradiation of chlorophyll-*a* in a rigid solvent at liquid nitrogen temperature. The chlorophyll was prepared according to the method of Zscheile and Comar[5], and made up to $1{\cdot}2 \times 10^{-5}$ *M* in a solvent consisting of ether, *iso*pentane and ethanol in 8 : 3 : 5 volume ratio. Solutions were contained in a 'Pyrex' cell of 6 mm. square cross-section and were carefully degassed on the vacuum line. The cell fitted snugly into a hole in a cylindrical dural metal-block thermostat placed in an unsilvered 'Pyrex' Dewar vessel, and supported within the Dewar vessel by a metal extension rod which dipped into liquid nitrogen. A small hole drilled through the block allowed a beam of white light to be passed through the solution immediately behind the front face of the cell. The emergent light then passed through a constant-deviation spectro-

meter and on to an *IP*-22 photomultiplier tube. Through a slot in the thermostat block, the horizontal image of a quartz capillary 1,000-watt mercury arc (G.E., type *AH*-6) was focused precisely along the line of the measuring beam by a spherical 'Pyrex' flask filled with water. An 'Aklo' heat filter and shutter were also interposed in the path of the exciting light. Readings were taken throughout the visible spectrum with the arc shutter alternately closed and open. Suitable small corrections for fluorescent and scattered exciting light were made.

Slight but definite, immediate, and reversible changes in the absorption spectrum were observed when the dye solution was cross-illuminated. The red and blue peaks were diminished while absorption was enhanced in the far red (7400–7000 A.) and the yellow-green (5900–4800 A.).

The spectral changes observed at liquid-nitrogen temperatures in pure chlorophyll solutions parallel much more marked reversible changes observed in de-oxygenated rigid chlorophyll solutions containing quinones or imines (10^{-2}–10^{-3} *M*). In such solutions the spectral changes caused by irradiation with red light persist until the solvent is melted and permit precise measurement in a suitably modified Beckman spectrophotometer. Again, in the 'bleached' state it is found that the absorption in the far red and yellow-green is enhanced, while the red and blue peaks fall.

In the glassy solution of pure chlorophyll, at the low concentrations used, bimolecular dismutation reactions are most unlikely. If we assume that the colour change is due to transfer of an electron or hydrogen atom from the dye to the solvent, we can readily understand the apparent stabilizing effect of oxidants on the 'bleached' state. In agreement with this, it is found that in irradiated glassy solutions of diphenyl-*p*-phenylene diimine and erythrosin, the known absorption spectrum of the semiquinone of the imine can be demonstrated.

Rabinowitch has suggested that the long-lived excited state of certain sensitizing dyes is itself due to a redox reaction between dye and solvent[4]. This view finds some support in these experiments. The explanation of the long life-time as due to an electronic metastability[6] is rendered somewhat doubtful by the failure to observe phosphorescence[7]. The interpretation of Franck and Livingston[3] that the long-lived state is a dye tautomer is perhaps not too different from Rabinowitch's view. If we consider that the redox reaction takes place within a dye – solvent complex, then it depends simply on the stability of the complex whether the process should be termed 'tautomer' formation or a true hydrogen transfer.

A full account of this and similar experiments will appear shortly. This work is supported by grants from the Research Corporation and the U.S. Atomic Energy Commission (Contract #*AT* (30-1)—820).

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Multiplication of Aster-Yellows Virus in its Vector

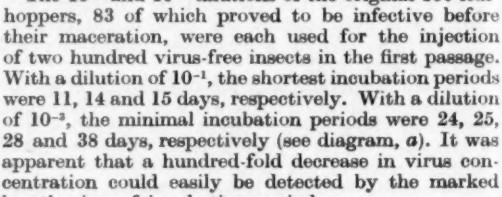
The vector of aster-yellows, *Macrosteles divisus* Uhler, may acquire the virus through feeding[1] or by injection[2]. An incubation period of several days must elapse between the time when the insect first acquires virus and the time when it becomes permanently infective, as manifested by the transmission of virus through feeding on healthy susceptible plants. Infective insects retain virus as long as they live. Considerable evidence that aster-yellows virus multiplies in its insect vector has accumulated[3–6].

Recently, further evidence for multiplication has been presented[7]. The virus was carried in ten serial passages from insect to insect, and the calculated dilution of the original inoculum, if no multiplication had occurred, would have increased by a factor of 10^{-4} with each passage, that is, to 10^{-40}.

To obtain additional evidence on this point, measurements of virus concentration were made in samples of insect juices used for the injection of the first, seventh and ninth passages. These measurements employed a newly developed method, based on the relationship between the amount of injected virus and the length of incubation period, tested under controlled environmental conditions[6]. The volume of inoculum, 1/8,000 c.c. per insect, was delivered by a specially calibrated microsyringe[8]. The surviving injected leafhoppers were kept under controlled light (1,500 foot-candles), constant wind velocity and humidity, at 25° C. ± 0·5° C. in chambers described elsewhere[7]. Non-injected insects from the same stock served as controls and proved virus-free. Individual leafhoppers, fed through screens of small cages fastened to the leaves[8], were transferred to new sets of young healthy aster plants at daily intervals (first passage) or three times weekly (seventh and ninth passages). Exposed plants were observed in a greenhouse for six weeks.

The 10^{-1} and 10^{-2} dilutions of the original 100 leafhoppers, 83 of which proved to be infective before their maceration, were each used for the injection of two hundred virus-free insects in the first passage. With a dilution of 10^{-1}, the shortest incubation periods were 11, 14 and 15 days, respectively. With a dilution of 10^{-2}, the minimal incubation periods were 24, 25, 28 and 38 days, respectively (see diagram, *a*). It was apparent that a hundred-fold decrease in virus concentration could easily be detected by the marked lengthening of incubation periods.

In the seventh passage the shortest incubation period with inoculum at 10^{-3} dilution was 31 days



Virus concentration in samples of the first, seventh and ninth passages measured by the length of incubation period in injected insects

for the first two insects, 35 days for the third, and 52 days for the fourth (diagram, *b*). These figures seemed to suggest a slight lowering in concentration of virus in the inoculum of this passage, as compared with the original source. Eighty-three of the original hundred insects proved to be infective before their maceration, whereas for the seventh passage inoculum only five of twenty-two were infective.

The insects of the eighth passage were tested for 65 days, and only the four which proved infective were used as source for the inoculum of the ninth passage. This means that this source consisted of juices from insects that were 100 per cent infective, diluted to 10^{-8}. This passage gave minimum incubation periods of 23, 23, 25, 27, 29 and 29 days, respectively (diagram, *c*), and indicated that concentration of virus was not decreased after eight passages.

Thus the experiments provided new and direct evidence for multiplication of aster-yellows virus in its vector, and confirmed earlier findings. The viruses of rice stunt[10,11], club leaf[12,13], and wound-tumour[14,15] diseases have previously been shown to increase in their insect vectors. These four infective agents cannot be considered as plant viruses only. They serve as a connecting link between plant and animal viruses.

We do not know how viruses multiply, but it seems unlikely that a large precursor molecule would occur in such unrelated organisms as animals and plants, as would be required by the virus–precursor hypothesis. The perfect adaptation to the insect vectors, manifested by the fact that these viruses cause no visible harm to the animal host, allows some speculation as to their origin in insects, rather than in plants.

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Experimental and Natural Infection of Birds by *Coxiella burneti*

IT is well known that the epidemiology of *Q* fever is always associated with the presence of animal carriers of *Coxiella burneti*, particularly sheep and cows; more rarely infection is transmitted by equines or by dogs. Interhuman contagion occurs only in exceptional cases. However, the epidemiology of the disease is still obscure and in many outbreaks it is not possible to trace the origin of the contagion and the manner of transmission of the pathogenic agent.

In the course of a wide research programme on *Q* fever, now being carried out in Italy, we investigated whether certain domestic and semi-domestic birds had any importance in the diffusion of this disease. To our knowledge, attempts to transmit *Q* fever to birds have been carried out only in the Rocky Mountains Laboratory, where the presence of *C. burneti* in the blood and in the organs of chickens infected endovenously had been noted[1].

In one experiment, we inoculated, by the intraperitoneal route, a goose, a turkey, two ducks, three chickens and six pigeons previously subjected to serological control with a suspension of *C. burneti* (Grottazzolina strain, cultivated in yolk sac). The animals showed no evidence of disease, but after one month, in the goose and in five pigeons, the complement deviation was definitely positive (greater than 1 : 16).

In the second experiment, we infected twelve pigeons, four sparrows (*Passer italicus*) and five goldfinches (*Chrysomitris spinus*) by the oral route with some drops of a *C. burneti* suspension. The first sero-diagnosis was carried out after fifteen days in the pigeons. One of them showed the complement deviation greater than 1 : 16; three others showed deviation of only 1 : 4–1 : 8; eight gave negative results. A second sero-diagnosis on the twenty-sixth day confirmed the results of the previous one, with only two exceptions: a second pigeon, negative in the beginning, became absolutely positive, and another one, that was positive 1 : 4, became absolutely negative.

After a further fourteen days we bled the two positive pigeons again. One of them was again negative and the second one was only slightly positive (1 : 8). Forty days after infection, twelve pigeons, two ducks, the goose and five goldfinches were killed and a broth of the kidneys of each single animal was injected singly in guinea pigs. Their serum was then examined after one month. In five cases the result was definitely positive; this was for guinea pigs infected with kidney broth of four pigeons infected orally and one by the endoperitoneal route. It is interesting to note that in two of these cases the pigeons only showed a very slight and brief positive serum reaction. Of the four sparrows, one was killed after nine days and two after twenty-five days, and the presence of *C. burneti* in their kidneys was verified through inoculation in guinea pig. The fourth sparrow was bled after a month and gave a negative serum reaction.

After completing this experimental work, we wished to check whether similar effects occurred in Nature. As control, we bled for complement deviation twenty-eight pigeons, six hens, two geese, two ducks and a turkey, all originating from localities where no cases of *Q* fever had been reported. All gave a negative response. We then analysed the sera of birds originating from areas where *Q* fever had recently affected both animals and man. The sera of thirty-two pigeons, three chickens and one goose were examined. Five of these showed positive results, namely, one goose coming from Loto (Liguria), kindly sent to us by Dr. Lopez (1 : 64), and four pigeons sent us by Dr. Valli from the San Marino Republic[2]. Of the latter, three showed complement deviation up to 1 : 8 and the other up to 1 : 64. A further seven sera showed only a slight reaction (1 : 4). The most positive pigeon, re-examined after 130 days, was found to be negative. Then it was killed, a broth made from its kidneys, and a guinea pig inocu-

lated with the broth. The guinea pig showed serologically proved infection from *C. burneti*.

Our investigations, which are continuing, suggest that certain birds can be experimentally infected by the oral route, with *C. burneti*, and also that such infection may occur naturally. Birds thus infected may harbour the *Rickettsia* in their kidneys for a period of time not yet known exactly, but certainly for more than forty days, and later they presumably eliminate it with the urine.

The search for complement deviating antibodies in the blood of birds is scarcely of practical importance, because the immunity reaction of birds to infection from *C. burneti* is often small and brief, and the birds may continue to harbour *Rickettsia* even after remaining or becoming sero-negative. Only further investigations will show clearly the importance that some birds might have in the epidemiology of *Q* fever.

In our opinion, some birds, such as pigeons and sparrows, may be important agents, since they live near inhabited centres and stables and are often pecking and scraping among excrement, which notoriously may contain *Rickettsia*. From a theoretical point of view, our research work establishes a further affinity between the biology of *C. burneti* and that of the agents of ornithosis and psittacosis.

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Frequency of Recombination in *E. coli K* 12

According to the technique introduced by Lederberg[1] and generally adopted, the cross between two bacterial strains differing in growth-factor deficiencies is carried out by means of mixing on "minimal medium"[2] suspensions of young cultures of the two strains, which have been washed by centrifugation twice in saline. In the course of research in this Department, we observed that if instead crosses are made between the first supernatant liquids, which are usually thrown away, the ratio of prototrophs to parental cells is many times greater.

The strains of *E. coli K* 12 used were 58–161 V_6^r (*B- M-*) and *W* 677 (*T- L- B*$_1$-) and were cultured on full-medium agar slopes.

The crosses were all made on plates of "minimal agar" supplemented with vitamin B_1, thus increasing throughout the prototroph yield, by eliminating the compulsory recombination between B_1 and *BM*. The twice-washed cells were suspended in saline so as to be about 10^{10}/ml. The supernatants collected apart contained on the average 10^8 cells/ml. In both cases we plated on "minimal agar" different quantities varying from 0·01 ml. to 0·05 ml. of the suspension of each strain.

Under these conditions, the average ratio of prototrophs to parental cells is of the order of 10^{-6} to 10^{-7} when using twice-washed cells, but of 10^{-4} when using supernatant liquid. At least four interpretations are possible: (*a*) a negative correlation within certain limits between the number of parental cells and the yield of prototrophs, owing to some sort of inhibition; (*b*) the recombining cells have a lesser tendency than the others to be sedimented, possibly due to smaller size or lower density; (*c*) the supernatant liquid contains some substance which stimulates recombination, arising either from the cells or from the medium on which they have been grown; (*d*) the supernatant liquid contains enough growth factors, derived from the medium on which the cells were grown, to allow some growth of the cells, so that the high frequency of recombination is apparent rather than real.

Although in our opinion the last seemed the most probable, we carried out some experiments to test the other possibilities.

(1) Diluting in saline the cell suspensions which are collected after the second centrifugation, to such an extent as to have the same number of cells per ml. as in the supernatants, that is, 10^8, and using these diluted suspensions for crosses, the ratio of prototrophs to the parental cells remains about 10^{-6} to 10^{-7}.

(2) Using for the crosses the supernatants from the second centrifugation, which it should be noted contain approximately the same number of cells as the first supernatants, namely, 10^8/ml., the prototroph yield is about 1 out of 10^7 parental cells.

(3) First supernatants which have been sterilized either by means of filtration or by heat treatment were used to suspend the twice-washed cells. The prototroph yield was then increased to $1/10^4$.

(4) A non-inoculated slope of the same full medium which was used for culturing the parental strains was washed with saline in exactly the same way as when collecting cells. The liquid obtained was used in the same way as the sterilized supernatant in (3), and was found to have the same effect on prototroph yield.

(5) Twofold dilutions ranging from 1 to 1/16 of sterilized supernatants (as in (3)), and of the liquid from a washed non-inoculated slope (as in (4)), when added to the twice-washed cells lead to a yield of prototrophs inversely related to the dilution.

(6) Some mixtures were made in liquid "minimal medium" of twice-washed cells of the two strains, and of the two supernatant liquids (unsterilized), in order to facilitate the process of taking samples at intervals to observe the changes in cell numbers. Under these admittedly somewhat different conditions, the number of cells did not increase significantly during the first six hours after inoculation when the mixtures were made between twice-washed cells, whatever numbers of parental cells were used; but when the mixtures were made between supernatant liquids, the number of cells increased about a hundredfold within the first six hours.

(7) The same experiments have been carried out substituting 58–161 *Hfr* (high frequency of recombination[3]) for the 58–161 V_6^r. The yield of prototrophs when *Hfr* supernatants were used as in (3) and in (5) was not significantly different from when 58–161 V_6^r supernatants were used. Also mixtures of *Hfr* strains with *W* 677 were made in liquid medium as in (6), and the number of cells did not increase significantly within six hours.

It seems to us that the results of experiments (1) and (2) are evidence against the hypothesis (*a*), and experiments (3), (4) and (5) against hypothesis (*b*). The results of experiment (6) seem to be in favour of the fourth rather than the third hypothesis. We conclude that the increased frequency of recombination which we observed in crosses of supernatants is probably only apparent, being due to multiplication

of the cells within the first few hours to about the same extent as the prototroph yield is increased, the multiplication being supported by growth factors present in the supernatant liquid and presumably derived from the full medium on which the parent strains were cultured.

On the other hand, the experiments with the *Hfr* strain, while supporting the former conclusion, also give some indication that the high frequency of recombination in crosses involving the *Hfr* strain is not to be accounted for in the same way as the behaviour of the supernatant liquids.

More details and further results will be published later.

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An Example of Parasitism among Polychætes

I have observed a case in which the young of one polychæte annelid, *Arabella*—probably *A. iricolor* (Montagu), the cosmopolitan species which is common to the Woods Hole area—parasitizes another polychæte, namely, *Diopatra cuprea* (Bosc.). On August 24, I recovered fifty-three complete worms of the genus *Arabella*, and the parts of approximately ten others from one adult *Diopatra*. The segment from which the parasites were recovered was approximately one and a half inches in length. The *Arabella* ranged in size from small worms of approximately thirty segments without eyes or setæ to large worms with four eyes (arranged in the transverse row typical for the genus) and with numerous segments (up to approximately 180), some of which contained setæ. The largest parasite was approximately 5 cm. in length, as compared with the adult *Arabella*, which ranged in size from 50 cm. to 60 cm. in length[1]. The larger parasitic *Arabella* appeared to lie free in the cœlom, whereas the smaller ones were held in place by the small parietal blood vessels in the body-wall of *Diopatra*.

On August 27, a second infected *Diopatra* was observed. This animal and the other infected worm came from the same batch, which was dug at Hadley Harbor, Nonamesset Island, near Woods Hole, Massachusetts. Most of the *Arabella* recovered from the second infected animal were small. Twenty-six complete worms and parts of approximately four others were obtained. Most of these small parasites had no eyes, no setæ, and relatively few segments, a number having as few as seven segments.

Several years ago, during the first part of August, Dr. Frank Brown observed three or four large *Arabella* emerging from the body cavity of *Diopatra* (personal communication). He suspected, at that time, that *Arabella* may normally go through certain stages of its life-history as a parasite in *Diopatra*. The observations reported here confirm Dr. Brown's suspicions.

The significance of these observations lies in the fact that very few cases of parasitism have ever been described among the polychætes and rarely, if ever, has a polychæte been described which parasitizes another polychæte. Dr. Ralph Smith[2] has reviewed a case which was described by Koch in 1847 as an example of viviparity in *Marphysa*. Certain later workers considered this to be a case of a parasitic lumbrinereid. It may be noted that *Marphysa*, *Lumbrinereis*, *Diopatra* and *Arabella* are all members of the same family, the Eunicidæ.

Just how the stages of *Arabella* here reported get into the tube-dwelling *Diopatra* is, as yet, an unsolved problem.

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Hunger-Reaction of Flies (*Musca*) and the Functions of their Stomatogastric System

During my work with house flies (*Musca domestica* L.) I noticed one day that the bodyless heads of about ten flies all made drinking movements when their tongues came in contact with sugar water, but, probably due to quick desiccation of the œsophagus, no sugar water ever passed through this passage. After some time, the sucking movements became more vigorous and then rather suddenly stopped. In the case of flies with their tongues forcibly in touch with sugar water, the pumping activity of the fulcrum, even when the crop was full, never ceased. Only the contra pressure from the crop prevented a further intake. These experiments suggest that the sucking reaction takes place independently of the hunger- or thirst-condition of the fly.

Allowing a fly to walk over a sheet of filter paper sprinkled with sugar water, it was found that a starved fly will stop as soon as one of its front tarsi comes in contact with a moistened spot, stretch out its tongue and try to drink.

In a number of starved flies the crop was ligatured. Two of these flies showed hunger-reaction after the operation. In four cases when the crop was removed after a small meal, the flies' hunger-reaction remained. The reverse experiment, in which the crop was removed from three flies after they had been allowed to eat as much as they desired, showed that none of them behaved as if it was hungry. Flies without a crop eat often and little at a time, but otherwise they behave normally. Seven flies had the abdomen removed after a big meal. Not until an hour or two later did their thirst- and hunger-reactions return, and then their reactions to sugar water and distilled water increased rapidly. The flies were able to detect a droplet of water near them by means of their antennæ, and then if their front tarsi were simultaneously brought into contact with droplets of sugar water and pure water, they turned towards the sugar water. From these experiments it may be concluded

that it is not the content of the crop which determines whether a fly shows hunger or not.

Marchal[2] claims that a *Dytiscus* in which the frontal ganglion is destroyed is unable to swallow. In nine cases where the ganglion was removed from flies, they were able to drink and swallow, and in none of the cases did the operation appear to influence the hunger-reaction. The peristaltic movements were not obviously disturbed. A similar result was obtained from a control experiment with a grasshopper from which the left half of the head and thorax was removed. It swallowed normally after the removal of the frontal ganglion. I am thus unable to explain the function of this ganglion.

I tried to sever the sympathetic nerve connexion from the mid-intestine to the posterior side of the brain. Three flies in which the œsophagus was ligatured behind the corpus cardiacum + ganglion hypocerebrale and the passage to the crop, just in front of the proventriculus[1], regained their hunger-reaction in its full strength. They drank more sugar water than normal flies and seemed unable to satisfy their hunger. Dissection afterwards showed that the mid-intestine contained sugar water. Inhibiting impulses seem thus to be conducted from the mid-intestine to the posterior part of the brain soon after a small amount of sugar water has passed through the proventriculus. The hunger-condition, however, is maintained for some time after a meal. This becomes evident from the fact that newly fed flies still turned towards a droplet of sugar water when touching it with their front tarsi, but, however, without drinking. After some time this reaction ceased. Preliminary experiments seem to indicate that the actual hunger-reaction is caused by the effect of the exhausted hæmolymph on the central nervous system.

The work is still in progress and further details will later be published elsewhere.

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Breeding of the Edible Turtle

The scanty literature on the green or edible turtle, *Chelonia mydas*, as reviewed by Ingle and Smith[1], agrees in allocating a definite breeding season (in no case more than six months) to this species, varying from April–August in the West Indies to October–February in Queensland.

The significance of monthly figures from three islands off the Sarawak (Borneo) coast summarized by Banks[2] appears to have been overlooked, perhaps because they were derived from Malay collectors and contain some noticeable contradictions (for example, totals on pp. 527 and 530 of ref. 2). Since 1947, accurate figures have been kept from these three islands, now no longer controlled by the Malay chieftains but through the Curator, Sarawak Museum. There can be no question that green turtles do breed in every month of the year on each island; a permanent staff collects eggs nightly. Adults are never killed. Figures for 1950 (including eggs replanted for hatching) are reasonably typical. The 1950 total of 2,357,644 eggs recorded was distributed as in the accompanying table.

Month	No. of eggs	Month	No. of eggs
January	24,264	July	495,191
February	26,205	August	503,688
March	42,798	September	370,626
April	75,247	October	194,228
May	171,510	November	90,122
June	315,533	December	48,232

Despite a definite 'summer' peak, 12 per cent of the eggs were laid in the six full monsoon months (November–April), which in 1950 was often severe, making it very difficult for the turtles to get ashore on the three tiny (total six acres) beaches. On only one night (December 12) in the year did no turtle come ashore and lay.

This situation raises points of general interest in connexion with breeding cycles, and is being further studied. It is, however, possible that it is not peculiar to this area. Careful studies of this economically important and readily observed species are exceedingly meagre. Even the fullest study, that of Moorhouse[3] on the Great Barrier Reef, only covers five months (1929–30) and takes much for granted. For example, referring to statements by previous writers that incubation takes six to eight weeks, he concludes (ref. 3, p. 10) that "the present investigations have proved this a fallacy"—because his observations gave 65–72 days. But he only studied eleven nests. In Sarawak, the longest incubation period recorded so far is 65 days, the shortest 50. Ninety clutches laid in the height of the 1950 season (August) averaged 52 days.

In the monsoon, hatching is on the average slower. There are interesting possibilities for comparative work over the enormous range of this common (though decreasing) species, the habits of which lend themselves to exact observation and statistical checking. We here would welcome any research co-operation or co-ordination.

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Similar Joint Action of Insecticides

Bliss[1] defined the similar joint action of poisons in such a way that the quantal responses to mixtures of poisons acting similarly could be predicted from the separate toxicities of the components of the mixtures. Finney[2] revised Bliss's treatment of the subject, and both Finney[2] and Swisher[3] have shown that mixtures of certain insecticides were of the toxicity so predicted. If z_1 and z_2 are the doses of poisons A and B respectively, the probit responses, y, produced by A and B alone are usually given respectively by:

$$y = \alpha_1 + \beta_1 \log z_1, \quad (1)$$

$$y = \alpha_2 + \beta_2 \log z_2. \quad (2)$$

Provided, and only provided, that $\beta_1 = \beta_2 = \beta$, the probit response to z_1 of A and z_2 of B applied together is, according to Bliss's scheme, predicted by Finney's equation (8.4), which may be conveniently expressed in the form:

$$y = \beta \log (z_1 h^{\alpha_1/\beta} + z_2 h^{\alpha_2/\beta}), \quad (3)$$

where h is the base of the logarithms. Equation (3) reduces to (1) or (2) as z_2 or z_1 is made zero. Bliss's hypothesis of similar action does not permit A and B to act similarly if $\beta_1 \neq \beta_2$.

Cases[4,5] have been appearing, however, of insecticidal compounds, very closely related chemically, which when applied separately gave probit-log-dose lines of different slope, that is, $\beta_1 \neq \beta_2$. The compounds were so similar chemically that they seem likely to act similarly in the sense of having the same site of toxic action within the insect. Their joint action was not investigated, but it appeared that the statistical treatment of similar joint action needed to be revised so as to accommodate cases in which $\beta_1 \neq \beta_2$. We also have obtained data (see below) for closely related compounds which gave β_1 different from β_2.

We regard two poisons as acting similarly merely if they produce the response by causing the same system to react or fail, and if when applied jointly neither poison influences the behaviour of the other. From this definition the responses produced by mixtures can be predicted in a number of ways according to the further assumptions made, for unlike Bliss's definition it makes no assumption as to the proportionality of equivalent doses of the two poisons, or the distribution and correlation of tolerances. What appears to be the most useful set of further assumptions and its implications are now given.

Suppose that (*a*) the amount, λ_1, of A reaching the site of action can be substituted at a constant proportion for that of B, λ_2, producing the same response when applied alone; (*b*) the minimum effective log-amounts acting are normally distributed with standard deviation $1/\theta$ for both poisons; and (*c*) the amounts of poisons A and B acting are related to the doses by $\lambda_1 = \mu_1 z_1^{\eta_1}$ and $\lambda_2 = \mu_2 z_2^{\eta_2}$. From the definition of similar action and from (*a*) and (*b*), it follows that y is given by an equation of the same form as (3), but with λ_1 and λ_2 in place of z_1 and z_2, and θ in place of β. Applying assumption (*c*) to this equation in λ_1, λ_2 and θ, y is given by:

$$y = \theta \log (z_1^{\beta_1/\theta} h^{\alpha_1/\theta} + z_2^{\beta_2/\theta} h^{\alpha_2/\theta}). \qquad (4)$$

The extension required is achieved by (4), since if $\eta_1 \neq \eta_2$, $\beta_1 \neq \beta_2$. Equation (4) reduces to (3) if $\eta_1 = \eta_2 = \eta = 1$, that is, $\beta_1 = \beta_2 = \beta = \theta$, and to (1) or (2) as z_2 or z_1 is made zero. If $\beta_1 = \beta_2 = \beta$, equation (4) will predict the joint toxicity of A and B as greater or less than that predicted by (3) according to whether θ is greater or less than β. In effect, (4) is the result of applying Bliss's and Finney's concepts to the amounts of poison acting instead of to doses, and then making assumption (*c*). Equation (4) is easily extended to the general case of any number of poisons by inserting further terms of the same form within the brackets.

Equation (4) has been employed in the analysis of data (see table) for the toxicity of DDT and methoxychlor (MOC) to flour beetles, *Tribolium castaneum*, applying the insecticides in Shell oil *P*31 by a film method[6]. The numbers of beetles on which the percentages are based are given in brackets. The regression equations for the separate insecticides were:

		$\chi^2_{(1)}$	P
DDT	$y = 5{\cdot}834 + 2{\cdot}656 \log z_1$	0·53	0·48
MOC	$y = 4{\cdot}954 + 3{\cdot}737 \log z_2$	2·11	0·15

The regression coefficients differed significantly ($\chi^2_{(1)} = 8{\cdot}8$, $P = 0{\cdot}003$), excluding the fitting of (3). Fitting (4) by minimum χ^2, θ was estimated as 3·22,

TOXICITY TO *Tribolium castaneum* OF DDT, METHOXYCHLOR, AND COMBINATIONS OF THE TWO, APPLIED IN *P*31 AS FILMS ON FILTER PAPER

(Deposit, 19 mgm./10 sq. cm.)

		MOC % w/v			
		0	0·4	0·8	1·6
DDT % w/v	0	0 (200)	7·5 (199)	29·7 (148)	77·9 (199)
	0·2	14·5 (200)	26·0 (150)	63·6 (151)	—
	0·4	43·6 (149)	66·2 (148)	78·7 (150)	—
	0·8	70·9 (199)	—	—	—

but comparison of the predicted and observed mixture mortalities gave $\chi^2_{(3)} = 14{\cdot}8$, $P = 0{\cdot}002$. This value of P is an under-estimate, because the indeterminacy of the predicted mortalities was not allowed for; but the predictions were almost certainly not fulfilled. However, further data for methoxychlor alone indicated that for this insecticide probit mortality was not linear in log-concentration, though the data of the table were not full enough to reveal this. Thus the assumption implied in (2) was not reliable, and (4) could be expected to break down at the extremes of the dose ranges of the table. Omitting the observation for (0·2, 0·4) per cent, $\theta = 3{\cdot}65$ gave a minimum $\chi^2_{(3)}$ of 0·79, whence $P = 0{\cdot}65$: for the middle of the dose ranges (4) predicted the mortalities satisfactorily.

Finney[2] analysed two sets of data for the joint toxicity of rotenone and pyrethrins to houseflies. Taking (3) as the standard, he found evidence of synergism in one set, but considered that both sets could be accounted for on the assumption of a common coefficient of synergism. However, a preliminary analysis has indicated that (4) also accounts for the data as a whole, assuming that $\eta = 0{\cdot}91$ for both sets, and without assuming any special interaction such as the term 'synergism' implies. Turner[7] tested the joint toxicity of nicotine and pyrethrins to milkweed bugs, and concluded that synergism occurred; but (4) appears to account for the data of his Table 1, with $\eta \simeq 0{\cdot}4$, and the assumption of synergism is again unnecessary.

Additional experience will be needed before the usefulness of equation (4) can be fully assessed. However, it is to be noticed that, if the other parameters are fixed, y increases with an increase in θ. Thus highly potent mixtures of insecticides might be obtained if the components were such that θ was appreciably greater than β_1 or β_2.

This work has been carried out as part of the research programme of the Pest Infestation Laboratory, and this account is published by permission of the Department of Scientific and Industrial Research. We are indebted to Dr. D. J. Finney for letting us have details of his analysis of data on the joint action of rotenone and pyrethrins.

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Growth of Pigs given Skim Milk Soured with Nisin-producing Streptococci

Stokstad and Jukes[1] reported that diets supplemented with aureomycin hydrochloride have a growth-stimulating effect. Since then, many reports have confirmed that a number of antibiotics may act as growth stimulants in pigs and poultry. It was of interest to see if nisin[2], the antibiotic produced by *Str. lactis*, had a similar effect. The nisin used was not concentrated or purified, but was obtained by growing the cultures of *Str. lactis* in skim milk, when 100–200 units/ml. (*c.* 50 units = 1 μgm.) is always produced.

Two groups of twelve pigs each were fed individually on a cereal diet supplemented with sour skim milk, at the rate of 4–6·5 lb. a day according to liveweight, for a period of 126 days, that is, the whole fattening period of a bacon pig. The milk for one group was soured by a streptococcus not producing nisin, and the other group received milk soured by nisin producing strain 12 [3].

Table 1 gives the results as far as rate of growth and efficiency of food utilization are concerned.

Table 1. Growth and Food Utilization of Pigs Fed Skim Milk Soured by Nisin- and Non-Nisin-producing Streptococci

Treatment	Skim milk supplement containing nisin	Skim milk supplement not containing nisin
Av. initial weight (lb.)	44·0	44·6
Av. gain during experimental period of 126 days (lb.)	166·3	164·4
Food required per 1 lb. liveweight gain :		
Meal (lb.)	3·35	3·35
Skim milk (lb.)	4·49	4·51

It is obvious from the values in Table 1 that nisin fed to pigs had no growth-stimulating effect. This confirms results obtained with chicks fed on diets supplemented with concentrated nisin[4].

Bacteriological examination of the fæces of the pigs was undertaken three times. Difficulty was experienced in isolating streptococci from fæces; they appear to form a very small proportion of the bacterial population. The count varied between pigs more than it varied between the two treatments. The nisin fed to the pigs did not appear to change the bacterial count of the fæces.

After slaughter at the end of the experimental period, the gut contents of two control and two nisin-fed pigs were examined. One in each group had been fed 18 hr., the other 3 hr. before slaughter. From Table 2 one can conclude that neither the nisin-producing nor the non-nisin-producing streptococci established themselves in the intestine of the pig.

Table 2. Count of Streptococci in the Intestine of the Experimental Pigs

	Time between last feeding and slaughter (hr.)	Stomach		Small intestine		Cæcum		Colon	
		No. per ml.	Inhib. str.	No. per ml.	Inhib. str.	No. per ml.	Inhib. str.	No. per ml.	Inhib. str.
Nisin pigs	18	none	–	none	–	30	–	90	–
	3	300,000	+	500	+	10	–	50	–
Control pigs	18	120	–	200	–	20	–	40	–
	3	150,000	–	8,000	–	30	–	40	–

Although the results with nisin have proved negative, one should bear in mind that our diet contained much animal protein and that the growth-stimulating effect of antibiotics is much less pronounced on diets containing animal protein[5].

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Sept. 8.

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Production of Rust-resistant *vulgare* Wheats by Backcrossing

One of the main agricultural problems in Egypt is the susceptibility of all *vulgare* wheats to black stem rust. Severe losses are sometimes experienced[1], and even in the mildest seasons not less than 10 per cent of the crop is lost[2].

Breeding for rust resistance has not so far been satisfactory, and has culminated in the production by the Ministry of Agriculture of two varieties which show some resistance under favourable conditions. In adverse conditions, however, they suffer to a certain extent, and when I subjected them to artificial infection in this year's rust nursery, their resistance was completely broken down. They are Mokhtar and Giza 139 respectively.

As part of the programme of the Plant Breeding Section of the Royal Agricultural Society of Egypt for producing rust-resistant varieties, Mokhtar and Giza 139 were crossed in March 1946, and the F_1 seed, sown in November of the same year, was backcrossed with pollen from its Giza 139 parent in March 1947. From that time until now some seed from that first backcross was maintained by controlled selfing and sown in November 1950. I give these the genetic formula B_1S_2.

In the season November 1950–June 1951, proper artificial infections were employed, in which a mixture was applied of all the physiological races of *Puccinia graminis tritici* so far discovered in Egypt through the researches of the Plant Pathology Section of the Ministry of Agriculture. I wish to record here that one segregating family from that B_1S_2 formation stood up to this severe treatment and was quite free from infection.

When seed from this family was later germinated in the greenhouse to test its reaction in the seedling

Family No.	Race Nos.							
	9	14	17	19	21	24	42	53
1004/51 from the B_1S_2	0	0	0	1	1	1	1	1

stage against the physiological races mentioned above, the results were most satisfactory (see table). The system of recording the reaction is that adopted by Stackman and Levine[3].

This is a most striking result, since the reaction of its two parents under the same conditions, both in the greenhouse as seedlings and as adult plants in the field rust nursery, is definitely towards the susceptible scale.

Note. The formula of B_1S_3 is suggested here as a substitute for the existing system applied especially by the American geneticists, who would give the family the formula BC_1F_3. I suggest that F should only be restricted to families resulting from pure selfing as originally used by Mendel, and used ever since. S for selfing can be used in such cases where selfing started after an initial backcross, as in the case reported here. B is substituted for BC for backcross, since it seems much simpler. I am putting this suggestion before those concerned.

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In vitro Inhibition of *Bacterium tularense* by Methylene Blue

IT has been found that very low concentrations (0·5 μgm./ml.) of methylene blue inhibit the growth *in vitro* of *Bact. tularense*. This inhibition is of the same order of magnitude as that caused by the most potent antibiotics[1]. The dye had, however, no effect *in vivo*; doses of 0·5 gm. each, applied intraperitoneally for three successive days, did not protect mice infected even with low doses (1–10 LD_{50}) of the bacterium.

For the *in vitro* experiments, the organism was grown on a glucose–cysteine–blood–agar medium; the slopes were inoculated with a standard loop-full of a thick bacterial suspension. Three highly virulent strains and three of low virulence were used; the latter were derived from the former by means described in another communication[2].

As a rule, basic dyes of the methylene blue type are much more active against Gram-positive than against Gram-negative bacteria[3]. Thus *Diplococcus pneumoniæ* Type I is inhibited by 5 μgm./ml., *Staphylococcus aureus* and *Streptococcus pyogenes* by 10 μgm., and *Streptococcus fæcalis* by 20 μgm. of the dye, whereas *Shigella dysenteriæ* requires a dose of 200 μgm./ml.[4].

Although the position of *Bact. tularense* in the system of bacteria is not clear, some authors[5,6] classify the organism with the Pasteurella or Brucella group. A number of representatives of these two groups were, therefore, tested for their response to methylene blue with the same technique as *Bact. tularense*. Two strains of *Brucella melitensis*, *Brucella abortus*, and *Brucella suis* were completely inhibited by 5 μgm./ml. of the dye. On the other hand, two strains of *Pasteurella pestis* required 1,000 μgm./ml. of methylene blue for complete inhibition, and *Pasteurella pseudotuberculosis* and *Pasteurella septica* grew even at this concentration of the dye, though rather poorly.

Recent investigations have led to the view that low concentrations of methylene blue specifically interfere with metabolic reactions other than oxidation or fermentation processes[7]. If this theory be correct, it is likely that biochemically *Bact. tularense* resembles the Brucella group of bacteria.

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Aug. 29.

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Two Types of Inhibition of the Hydrogen–Oxygen Reaction by Hydrocarbons

THE inhibiting effect of hydrocarbons on the hydrogen – oxygen reaction was discovered during the course of a war-time study, described elsewhere[1], of the problem of exhaust flames from aero-engines. Preliminary experiments at that time showed that this inhibiting effect was obtained with a range of hydrocarbons from pentane to octane, as well as with the lower alcohols.

Recently, this inhibition has been studied in more detail by examining the effect of the simpler hydrocarbons on the second limit of hydrogen – oxygen mixtures in clean and potassium chloride-coated 'Pyrex' vessels. With propane, as with the higher hydrocarbons studied earlier, an almost linear relation between explosion pressure and inhibitor concentration is obtained, so that the effectiveness of the inhibitor may be conveniently defined by $i_{1/2}$ (the concentration required to reduce the limit by 50 per cent). A study of the effect of mixture composition, vessel diameter and vessel surface, shows that, to a first approximation, $i_{1/2}$ is directly proportional to the oxygen concentration, independent of the hydrogen concentration, independent of the diameter of the vessel, and is not substantially affected by change from a clean 'Pyrex' to a potassium chloride-coated vessel.

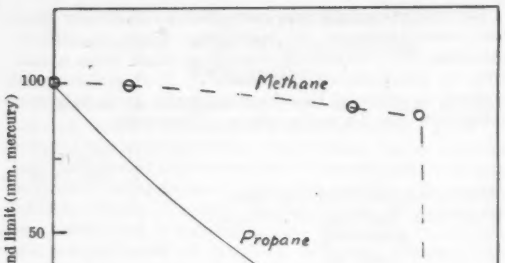
The dependence on oxygen concentration is most simply interpreted as a competition between the reaction of a centre with oxygen giving propagation or branching, and a reaction with propane which ultimately leads to termination. Since the only centres reacting with oxygen in the hydrogen – oxygen reaction are hydrogen atoms, the primary inhibition reaction appears to be uniquely defined. Addition of the reaction,

$$H + C_3H_8 \overset{k_7}{=} C_3H_7 + H_2,$$

to the accepted mechanism[2] for the second limit gives the relation:

$$c(P_0 - P) = k_7 i / k_6 y, \qquad (1)$$

where i, y are the mole fractions of propane and oxygen, and c is a constant determined by the third-



Inhibition of the second limit of a hydrogen–oxygen–nitrogen mixture by propane and methane. Clean 'Pyrex' vessel (23 mm. diameter) at 500° C.; molecular fraction of oxygen, 0·14, and of hydrogen, 0·28

body efficiency of the mixture in the termination reaction :

$$H + O_2 + M \overset{k_5}{=} HO_2 + M.$$

While this expression is consistent with the experimental results quoted above, it seems doubtful whether formation of the propyl radical can be regarded as termination, and the right-hand side of equation (1) should therefore include a factor F, the fraction of propyl radicals which are destroyed without propagation. Little evidence, as yet, has been found for any significant variation of F with experimental conditions, and thus the ultimate fate of the propyl radicals has so far eluded investigation.

In contrast with the above is the inhibition caused by methane, as shown in the graph. Increasing concentrations of methane produce only a relatively small decrease in the second limit until a critical concentration is reached which completely suppresses ignition. The critical methane concentration is found to be approximately proportional to the oxygen concentration, to be rather more sensitive to hydrogen concentration than in the case of propane, to increase as the vessel diameter is increased, and to be relatively unaffected by change in vessel surface from clean 'Pyrex' to potassium chloride-coated. It seems probable in this case, at least, that inhibition proceeds through the intermediate formation of formaldehyde, which has been shown to be a powerful inhibitor. In confirmation, analysis of mixtures which can be withdrawn without explosion shows that significant quantities of methane have been oxidized during the evacuation.

It is hoped to publish a detailed account of these and other results at a later date.

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Aug. 28.

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Estimation of Phenylpyruvic Acid

There are difficulties in the quantitative estimation of phenylpyruvic acid in urine. If ferric chloride or iron alum is added directly to the urine, a more or less copious precipitation of phosphates occurs, making accurate measurement of the characteristic green colour impossible. Penrose and Quastel[1] overcame this difficulty by adding 2 : 4 dinitrophenyl hydrazine to the urine and measuring the red colour produced with sodium hydroxide (cf. ref. 2). This assumes that, as is the case with normal urines, no ketone body other than phenylpyruvic acid is present in significant amounts.

Urine from phenylketonuries contains an ether-soluble acid, which reduces Briggs's reagent[3] and seems to be a phenol. This acid cannot be extracted from urine in the presence of Girard's reagent T or P, proving it to be a keto- (or aldehydo-) acid. Phenylpyruvic acid alone or dissolved in normal urine does not reduce Briggs's reagent. Other workers[4,5], using chromatography of the 2 : 4 dinitrophenyl-hydrazones on alumina columns, confirm that considerable amounts of a second keto-acid are present in phenylketonuric urines.

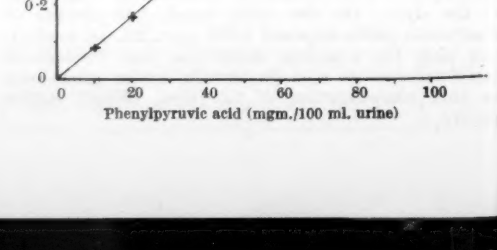
The other keto-acid in the urine would give false high results in Penrose and Quastel's method for phenylpyruvic acid[1], and the following method was therefore worked out. The urine is acidified (*p*H 1) and extracted with ether. The ether is evaporated in a stream of nitrogen at room temperature and the residue dissolved in a glycine – sodium chloride – hydrochloric acid buffer of *p*H 2·2. Ferric chloride is added and the resulting colour read at its maximum (2–3½ min. after mixing) in a photoelectric colorimeter using Ilford 607 filter ($\lambda_{max.}$ = 600 mμ). Fading is rather slow. The accompanying graph is a calibration curve obtained with pure phenylpyruvic acid. Recovery of phenylpyruvic acid added to normal urine varied from 98 to 100 per cent.

The results obtained with several urines in which phenylpyruvic acid was estimated (*a*) by this method and (*b*) by the dinitrophenylhydrazone method[1] (modified for photoelectric colorimetry) are as follow :

Apparent Phenylpyruvic Acid Content of Urine (mgm. per 100 ml.)

(*a*)	62	102	39	36·5	50	63	108	167	18
(*b*)	93	136	45	52	80	90	180	217	41·5

p-Hydroxyphenylpyruvic acid and homogentisic acid do not interfere in this method, since the blue-green colour they give fades completely within one



minute. By the dinitrophenylhydrazone method[1], *p*-hydroxyphenylpyruvic acid gives, mole for mole, 1·3 times the colour intensity given by phenylpyruvic acid.

The nature of the interfering substance remains obscure. It closely resembles *p*-hydroxyphenylpyruvic acid in most of its properties, but the rate of reduction of Briggs's reagent by the unknown is lower than in the case of *p*-hydroxyphenylpyruvic acid[4,7]. Nor is *ortho*- or *meta*-hydroxyphenylpyruvic acid identical with the unknown. The non-identity of the unknown keto-acid with *o*-, *m*- or *p*-hydroxyphenylpyruvic acid has also been shown by alumina chromatography of the 2 : 4 dinitrophenylhydrazones[5]. Urines from these patients do not give a positive Rothera reaction, suggesting that the unknown substance is not a β-keto-acid. A normal individual who ingested 5 gm. of pure phenylpyruvic acid excreted for a few hours (in addition to phenylpyruvic acid, phenyllactic acid and phenylacetylglutamine[8]) a keto-acid which reduced Briggs's reagent and which may be identical with the substance occurring in phenylketonuric urine.

We wish to thank Dr. B. H. Kirman for supplying many of the specimens examined; the Hospital for Sick Children for providing laboratory facilities and Imperial Chemical Industries, Ltd., for a research fellowship awarded to one of us (L. I. W.).

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Production of Electric Charges on Water Drops

Some time ago, experiments were made here in connexion with thunderstorm production to see if charges were produced when water drops splashed off ice. Charges were certainly produced of a considerable magnitude but, as seems the fate of many meteorological experiments, the results were most inconsistent. Not only did the magnitudes vary but also even the polarity. The only reproducible fact was that distilled water was always much more effective than ordinary water.

It was suspected that the charges arose from a contact potential between water and ice, so attention was directed to this. The problem had been studied by a few workers in the United States, and Workman and Reynolds[1] had found surprisingly large potentials, up to 230 volts, when dilute aqueous solutions froze. Our experiments are in accord with many of their statements, but we disagree on a fundamental point when they say this potential is at the water – ice interface (a contact potential of 230 volts seems most unlikely). Another statement, that there is no reverse potential on melting, is not always true.

Some simple experiments were made by cooling a cylindrical copper block in liquid air and then partially submerging it in distilled water in a beaker on an insulated stand. An electrometer measured the potential between a wire in the water and the block. As ice grew rapidly around the block, the potential rose quickly to some 50 volts. Thereafter what happened depended on the type of experiment. In the first type, the water in the beaker was near 0° C. at the start. As the block warmed up, the rate of ice formation slowed down and finally ceased with water and ice at 0° in equilibrium. In this case the potential decreased as the rate of ice formation decreased and became about zero in the equilibrium position. The water was always at a negative potential to the ice. In the second type of experiment, the water was initially at, say, 30°–40° C., in which case the ice after forming for some time began to melt. Here again the water initially developed a large negative potential which also fell off with the decreased rate of ice formation; but at about the point where melting began, this potential was reversed, the water becoming positive, and the potential grew in magnitude for a few minutes. It then decreased and sank to zero; compared, however, with the large negative potential, the reverse potential never reached more than a few volts.

Neglecting the small possible contact potentials between the block and the ice, and the wire and the water, the potential measured above is that across the ice plus that due to the ice – water surface. The experiment shows that: (*a*) while freezing is going on, a large potential is developed between distilled water and its ice, the water being negative; the magnitude of this potential depends on the rate of freezing; (*b*) while melting is taking place, a smaller reverse potential is developed, the water now being positive. It will appear later that (*a*) is invariably true, but (*b*) requires special conditions.

As a result of experiments too lengthy to describe here, the following theory of the action has emerged which may be of interest to meteorologists pending full publication.

A contact potential does exist between water and ice in equilibrium, but it is probably only a fraction of a volt, the water being negative. This potential is due to a positive charge on the ice surface and a negative charge on the water surface.

When freezing is taking place, it appears that this positive charge is frozen into the ice (but the negative remains in the water), and as soon as an indefinitely thin ice layer has frozen over the positive charge, the new uncharged ice surface by virtue of its contact potential takes a fresh positive charge from the water, which in turn is frozen in, and so on. There thus arises a volume distribution of positive charge in the ice and an equal negative charge on the water surface, causing a considerable drop of potential across the ice. The total potential between the block and the wire in the liquid is this large drop plus the small contact potential at the water – ice surface.

If the ice were a perfect insulator, this potential would grow indefinitely as freezing progresses, but the very slight conductivity of the ice allows this volume charge to leak slowly back to the surface, so that the transfer of charge from the liquid becomes less and less as the ice grows.

The reverse process does not appear to take place when melting occurs, for the much higher conductivity of water would prohibit the building up

of a volume distribution of charge in the water. The positive potential observed in the experiment described was due to positive charges in the ice which had not time to leak completely away before melting commenced, and which entered the water as the ice melted. (There had been a slight leakage over the insulators of the negative charge in the water.) Melting does not, therefore, put the water at a positive potential to the ice unless the ice has a positive charge initially.

The obvious applications to meteorology are these:

(1) If a small water drop impinges on an ice particle and part freezes on and the remainder rebounds, then a large negative charge is carried away and a corresponding positive charge is left in the outer layers of the ice. The actual magnitude of the charge depends on the size of the drops and their velocity of impact; but the very moderate velocity and comparatively large drops from a common Boots's sprayer give the order of 1 electrostatic unit of charge per cubic centimetre of distilled water sprayed on ice.

(2) If the conditions are such that the impinging water causes part of the ice particles to melt, then the melted portion will take away a positive charge, but only if the ice had originally a positive charge, as, for example, ice which had undergone process (1).

(3) The magnitude of the effect depends very much upon the purity of the water. Possibly certain impurities might even reverse the signs in (1) and (2).

Lord Cherwell, as always, has given every facility for these experiments.

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Sept. 10.

[1] *Phys. Rev.*, **78**, 254.

Rainfall in a 'Cloudburst'

Apart from an apocryphal record of 12·48 in. at Portree, Isle of Skye, on December 5, 1863, the largest amount of rain known to have been collected by a rain-gauge within a single day in the British Isles is 9·56 in. at Bruton, Somerset, on June 28, 1917. It has long been recognized, however, that the occurrence of far greater falls than this within much shorter periods than twenty-four hours must be invoked to account for the observed effects of those extremely heavy localized downpours which go by the name of 'cloudbursts'. Raindrops cannot fall through air rising at a vertical velocity exceeding 8 m./s. Upward currents having a higher order of magnitude of ascent than that are often engendered during severe convectional storms, and thus it may happen that, under conditions of prolific condensation in a well-developed cumulo-nimbus cloud, large quantities of water are carried to an altitude far above their level of origin. If for any reason the convectional movement suddenly ceases or diminishes rapidly, as it may do when the storm system reaches an escarpment of hills, the water accumulated aloft descends more or less *en masse*. At such times the surface soil beneath may either be washed away to rock level or be deeply excavated and heaped as by a giant plough over areas ranging from a few thousand square yards to 100 acres or more in extent.

Many meteorologists were sceptical when, in 1893, G. J. Symons[1], founder of the British Rainfall Organization, expressed his belief that a cloudburst (or 'so-called waterspout', as he put it) which wrought havoc at the Yorkshire village of Langtoft, near Driffield, during the evening of July 3, 1892, might have deposited not less than 100 in. of rain on a neighbouring hillside. But support for Symons's opinion has since come from the calculations of water engineers called upon to investigate the erosion effects of cloudbursts.

Although some five thousand rain-gauges are now maintained in the British Isles, the total area covered by all their receiving apertures combined is only of the order of 100 square yards; furthermore, a large majority of the gauges have a capacity of less than 10 in. Prospects of securing an instrumental measurement of a short-lived deluge localized over a few score acres and amounting to perhaps 50–100 in. are thus extremely small. It therefore seems desirable to direct attention to an occasion in bygone times when a cloudburst left, by chance, a rough quantitative record of its yield. While searching recently through seventeenth-century climatological archives, I found a scarce 12-page pamphlet entitled "Strange relation of the suddain and violent tempest which happened at Oxford, May 31 anno domini 1682". This publication, issued by the Oxford bookseller Richard Sherlock later in the year 1682, appears to have been overlooked hitherto by students of climatology.

There can be little doubt that the storm described justified the anonymous author's prefatory remark that its severity was such as "former ages have been seldome acquainted with". It broke early in the afternoon and was accompanied by "deadly, ruinous lightning", "frightful thunder", "a huge blustering and boisterous wind" and intense darkness. The rain, we are told, "seemed one continued spout or stream; so that in less than half a quarter of an hour these pouring cataracts raised the water in a round and uniform vessel of about 4 foot diameter near two foot higher than before, without the assistance of any other interfluent rivulet or commixing water". Bridges were borne down and houses demolished by the resulting floods.

It seems reasonable to suppose that by "near two foot" the chronicler of the cloudburst may have meant 1 ft. 9 in. or so, and that his "less than half a quarter of an hour" might have been about seven minutes at most. On these assumptions we get an average rate of approximately 3 in. per min. for the storm's yield of precipitation. This far surpasses such classical records of torrential rain in other parts of the world as the 1·02 in. measured in one minute at Opid's Camp, on the west front of the San Gabriel range, California, on April 5, 1926, and the 2·47 in. in three minutes at Porto Bello, Panama, on May 1, 1908. For comparison it may be added that the greatest observed rainfall for a half-hour period in the British Isles since instrumental data first became available is 2·90 in. at Cowbridge, Glamorganshire, on July 22, 1880. The length of the English 'foot' did not differ appreciably in the seventeenth century from its present value.

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Dagnall,
Berkhamsted, Herts.
Aug. 21.

[1] Symons, G. J., "British Rainfall 1892", 105.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 4

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. S. V. Barber: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION AND PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. W. A. Dickie and Mr. J. G. N. Drewitt: "Man-made Fibres".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Dr. K. J. R. Wilkinson: "Electromagnetism and Engineering Research".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Eric Shipton: "Everest Reconnaissance, 1951". (Admission by special tickets only.)

Tuesday, February 5

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. H. T. Jessop: "Photoelasticity and Engineering Design".*

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Burns Brown: "The Fumigation of Stored Products".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. R. C. McMillan: "A Gardener Looks at Holland".

Wednesday, February 6

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Ronald Duncan: "The History and Present Position of Tobacco Growing in England".

MANCHESTER METALLURGICAL SOCIETY (joint meeting with the IRON AND STEEL INSTITUTE, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Savage: "The Continuous Casting of Steel".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, MICROCHEMISTRY GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, February 7

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. W. P. Packard: "Himalayan Landscapes and Life".*

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Symposium on "The Physical Chemistry of Structural Changes in Solids" (arranged by Prof. A. R. Ubbelohde, F.R.S.).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. F. Y. Henderson: "Forest Products Research Laboratory".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. P. R. Bell: "Collecting Ferns in the Mountains of the New World Tropics"; Mr. Francis Rose: "The Ecology of the Lowland Bog".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.15 p.m.—Mr. R. B. Archbold: "A Probe Microphone for Measurement of Sound Pressures in Small Enclosures".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. G. Copland: "The Economics of Low-Voltage Electricity Supplies to New Housing Estates".

ROYAL AERONAUTICAL SOCIETY (joint meeting with the AERONAUTICAL INFORMATION GROUP OF ASLIB, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Discussion on "The Availability and Use of Aeronautical Information".

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. R. P. Linstead, F.R.S.: "Developments in the Chemistry of Macrocyclic Pigments".

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (at the Royal Technical College, Glasgow), at 7 p.m.—Prof. F. M. Bruce: "Some Special Oscillograph Techniques".

Friday, February 8

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Liverpool Engineering Society, The Temple, Dale Street, Liverpool), at 3 p.m.—Mr. F. Fancutt and Dr. J. C. Hudson: "The Work of the Protective Coating (Corrosion) Sub-Committee, B.I.S.R.A.".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting, followed by the Annual General Meeting.

ROYAL INSTITUTE OF PHILOSOPHY (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Mr. W. C. Kneale: "The Nature of Logic".*

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. P. Jackson: "Fuel Injection Systems for Large Marine Oil Engines".

Saturday, February 9

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Maurice Burton: "New Light on Animal Behaviour".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN GEOGRAPHY (with special interest in historical geography)—The Secretary, University College, Gower Street, London, W.C.1 (February 9).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, Municipal Technical College—The Director of Education, Education Offices, Union Street West, Oldham (February 9).

PRINCIPAL OF THE BRIDGEND TECHNICAL COLLEGE—The Director of Education, County Hall, Cardiff (February 9).

SENIOR LECTURER IN PRODUCTION ENGINEERING, Schools of Technology, Art and Commerce—The Chief Education Officer, 77 George Street, Oxford (February 9).

LECTURER IN CIVIL ENGINEERING SUBJECTS—The Principal, Heriot-Watt College, Edinburgh (February 15).

RUTHERFORD SCHOLARSHIP for research in any branch of the natural sciences—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (February 15).

ANALYSTS (with a university honours degree or the associateship of the R.I.C., and considerable experience in a Public Analyst's or similar laboratory dealing with food and drugs and water) in the City Analyst's Department—The Town Clerk, Municipal Buildings, Liverpool (February 16).

HEAD OF THE BUILDING AND CIVIL ENGINEERING DEPARTMENT—The Principal, Royal Technical College, Salford 5 (February 16).

ASSISTANT LECTURERS IN MATHEMATICS, PHYSICS, CHEMISTRY, AGRICULTURE, and DEMONSTRATORS IN BOTANY, GEOLOGY, GEOGRAPHY, PHARMACY—The Registrar, The University, Nottingham (February 25).

ASSISTANT AGRICULTURAL ECONOMIST in the Provincial Agricultural Economics Service—The Secretary, School of Agriculture, Cambridge (February 28).

SENIOR STRUCTURAL ENGINEER in the Architect's Department—The Architect, London County Council, The County Hall, London, S.E.1, quoting AR/EK/S8/1(67) (February 29).

DEMONSTRATOR IN CHEMISTRY—The Dean, Medical College of St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (March 1).

HEAD OF THE MINING DEPARTMENT, Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (March 1).

I.C.I. FELLOWSHIPS in chemistry, physics and allied subjects, including the biological application of chemistry, tenable at Durham or Newcastle—The Registrar, University Office, 46 North Bailey, Durham (March 1).

RESEARCH OFFICER to undertake some fundamental studies into starch protein dispersions in a flour-water dough, at the School of Applied Chemistry, New South Wales University of Technology, Sydney—The Director, Bread Research Institute of Australia, 111 Pacific Highway, North Sydney, Australia (March 1).

ROBERT BLAIR FELLOWSHIPS in applied science and technology, tenable in the Dominions, the United States or other foreign countries—The Education Officer (E.O./H.1/2), London County Council, The County Hall, London, S.E.1 (March 1).

ASSISTANT LECTURERS IN MATHEMATICS (candidates for one post should have qualifications in Pure, and for the other post in Applied Mathematics)—The Registrar, The University, Manchester 13 (March 4).

SCIENTIST, Grade I (with a university or other recognized training in mineral or chemical engineering, with wide experience of applied research, especially pilot plant operation in ore dressing, coal preparation or the heavy chemical field) (Ref. TT/418); a SCIENTIST, Grade II, (with a university or other recognized training in mineral engineering, and experience of ore dressing or coal preparation) (Ref. TT/419); and a SCIENTIST, Grade II (chemical engineer with diploma and wide industrial experience in fields relating to grinding, screening and briquetting) (Ref. TT/420); in the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (March 29).

CHAIR OF PATHOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

READER IN MARINE BIOLOGY, and a SENIOR LECTURER IN BOTANY, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

AGRICULTURAL CHEMISTS for Nigeria, Kenya and Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27106/5.

ANALYTICAL CHEMIST (Principal Scientific Officer or Senior Scientific Officer grade) in a Ministry of Supply Research Establishment in London, to lead a team investigating new methods of analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.40/52A.

ENGINEERS IN THE POSTS AND TELEGRAPHS DEPARTMENT, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27323/2.

GRADUATES (with first- or second-class honours in physical chemistry or physics) for fundamental work on combustion of solid fuels—The Assistant Secretary, (Ref. A.2), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

HEAD OF THE DEPARTMENT OF METALLURGY, County Technical College, Wednesbury—The Director of Education, Department F.E., County Education Offices, Stafford.

LECTURER IN METALLURGY—The Registrar, Loughborough College, Loughborough, Leics.

PHYSICIST (with a university degree in physics, or equivalent qualification, and an interest in experimental work on plant in actual operation) for research on methods of measurement and control of metallurgical furnaces (Sheffield)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICIST or MECHANICAL ENGINEER (honours degree in physics or mechanical engineering essential, and some research experience is desirable) to lead a small research team in the Laboratories in Sheffield —The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

SCIENTIFIC OFFICERS IN THE INTERNATIONAL RED LOCUST CONTROL SERVICE, Abercorn, Northern Rhodesia, for the study of the biology of the Red Locust with a view to ecological control and improved methods of mechanized chemical control—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27887.G.

SENIOR BIOLOGIST, an ASSOCIATE BIOLOGIST, an ASSISTANT BIOLOGIST, and a JUNIOR BIOLOGIST—The Director, Newfoundland Fisheries Research Station, St. John's, Newfoundland, Canada.

SENIOR EXPERIMENTAL OFFICER for the development of calibration procedure for radio test equipment and preparation of calibration publications (Ref. D.17/52A); EXPERIMENTAL OFFICER for the calibration of transfer standards involving output and attenuation measurements (Ref. D.18/52A); and ASSISTANT EXPERIMENTAL OFFICERS (2) for the calibration of transfer standards (*a*) involving frequency and pulse measurements and maintenance of the frequency standard and (*b*) involving bridge and miscellaneous measurements (Ref. D.19/52A); at an R.A.F. Signals Experimental Establishment in Bedfordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours in chemistry, or A.R.I.C. with appropriate experience, knowledgeable and experienced in paints and the paint industry) in the Admiralty Chemical Laboratory, Portsmouth—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.30/52A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement

Great Britain and Ireland

Wildfowl Inquiry Committee. Duck Adoption Scheme Third Annual Report, 1950–1951. Pp. 4. (London: Wildfowl Inquiry Committee, c/o British Museum (Natural History), 1951.) [1311

Department of Scientific and Industrial Research. Report of the Fuel Research Board with the Report of the Director of Fuel Research for the Period 1st April, 1946 to 31st March, 1949. Pp. vi+58+8 plates. (London: H.M. Stationery Office, 1951.) 3*s*. net. [1311

Royal College of Surgeons of England. Scientific Report for the Year 1950–1951. Pp. 32. (London: Royal College of Surgeons of England, 1951.) [1311

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 1, No. 5: Observations on Marsupials in the Royal Scottish Museum, with special reference to the Foetal Material. By Dr. W. C. Osman Hill. Pp. 145–167. (Edinburgh and London: Oliver and Boyd, Ltd., 1951.) 6*s*. [1411

Department of Scientific and Industrial Research: Road Research Laboratory. Road Note No. 10: A Rapid Method of Analysis for Bituminous Road Materials. By Dr. A. R. Lee, C. M. Gough and E. H. Green. Pp. 12+3 plates. (London: H.M. Stationery Office, 1951.) 1*s*. net. [1411

Abridged Wiring Regulations. Based on twelfth edition, 1950. Pp. iv+84. (London: Institution of Electrical Engineers, 1951.) 2*s*. 6*d*. [1411

The Radium Commission: a Short History of its Origin and Work, 1929–1948. Compiled by Dr. F. G. Spear and K. Griffiths. Pp. 157+16 plates. (London: H.M. Stationery Office, 1951.) 7*s*. 6*d*. net. [1511

Copper: its Ores, Mining and Extraction. (C.D.A. Publication No. 46.) Pp. vii+47. (Radlett: Copper Development Association, 1951.) Free. [1511

Southern Regional Council for Further Education. Fourth Annual Report. Pp. 47. (Reading: Southern Regional Council for Further Education, 1951.) [1511

Proceedings of the Royal Irish Academy. Vol. 54, Section B, No. 6: An Algal Survey of Lough Foyle, North Ireland. By Dr. Helen Blackler. Pp. 97–139+plates 4–6. (Dublin: Hodges, Figgis and Co., Ltd., 1951.) 5*s*. [1911

Annual Report of the Director of the Meteorological Office presented by the Meteorological Committee to the Secretary of State for Air for the Year April 1, 1950 to March 31, 1951. (M.O. 553.) Pp. 54. (London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [1911

Library Association. Pamphlet No. 6: A Mental Hospital Library; Report of an Experiment at Lancaster Moor Hospital in 1947–1949. By Kathleen M. Allsop. Pp. 44. 5*s*.; 3*s*. 6*d*. to members. Pamphlet No. 7: Prison Libraries. By Richard F. Watson. Pp. 45. 5*s*.; 3*s*. 6*d*. to members. Pamphlet No. 8: Children's Periodicals of the Nineteenth Century; a Survey and Bibliography. By Sheila A. Egoff. Pp. 55. 5*s*.; 3*s*. 6*d*. to members. (London: Library Association, 1951.) [1911

Productivity Report. Education for Management: Report of a Visit to the U.S.A. in 1951 of a Specialist Team concerned with Education for Management. Pp. xii+86. (London and New York: Anglo-American Council on Productivity, 1951.) 4*s*. 6*d*. [2011

Proceedings of the International Conference on Low Temperature Physics, held under the auspices of the International Union of Pure and Applied Physics, Oxford, August 22nd-28th, 1951. Edited by Dr. R. Bowers. Pp. xiii+165. (Oxford: Clarendon Laboratory, 1951.) 15*s*. [2111

National Trust for Places of Historic Interest or Natural Beauty. Report 1950–1951. Pp. 83. (London: National Trust, 1951.) [2211

National Institute of Economic and Social Research. Annual Report 1951. Pp. 32. (London: National Institute of Economic and Social Research, 1951.) [2211

University of Leeds: The Brotherton Collection. Sixteenth Annual Report of the Brotherton Collection Committee, Session 1950–1951. Pp. 9. (Leeds: The University, 1951). [2211

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Years 1948–1950. (Cmd. 8387.) Pp. iv+247. (London: H.M. Stationery Office, 1951.) 6*s*. 6*d*. net. [2211

The C.I.E. International Colour System Explained: a Simple Explanation of the International System for the Description of Colour, written for the Non-Technical Reader, and showing its Value for Colour Specification in Industry. By G. J. Chamberlin. Pp. 34. (Salisbury: The Tintometer, Ltd., 1951.) 5*s*. [2611

Handbooks for the Identification of British Insects. Vol. 6, Part 2*a*: Hymenoptera, 2, Symphyta, Section *a*. By R. B. Benson. Pp. 49. (London: Royal Entomological Society of London, 1951.) 10*s*. [2611

Aluminium Development Association. Information Bulletin No. 18: The Working of Aluminium in the Shipyard. Pp. 36. (London: Aluminium Development Association, 1951.) 2*s*. [2611

Other Countries

Canada: Department of Resources and Development, National Parks Branch. National Museum of Canada Bulletin No. 119 (Anthropological Series No. 30): Totem Poles. By Marius Barbeau. Vol. 2: Totem Poles according to Location. Pp. ix+435–880. 2.50 dollars. National Museum of Canada Bulletin No. 122 (Biological Series No. 42): The Hepaticæ of the East Coast of Hudson Bay (Notes on Nearctic Hepaticæ, 2). By R. M. Schuster. Pp. v+62. 25 cents. National Museum of Canada Bulletin No. 123: Annual Report of the National Museum of Canada for the Fiscal Year 1949–50. Pp. v+261 (60 plates). 1 dollar. (Ottawa: King's Printer, 1951.) [1311

Symposium on Biochemistry of Nucleic Acids. Sponsored by the Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 13–14, 1950. (Reprinted from *Journal of Cellular and Comparative Physiology*, Vol. 38, Supplement 1, July 1951.) Pp. 245. (Oak Ridge, Tenn.: Carbide and Carbon Chemicals Company, 1951.) Free. [1311

Beach Erosion Board: Corps of Engineers. Technical Memorandum No. 23: The Use and Accuracy of the Emery Settling Tube for Analysis. By D. M. Poole, W. S. Butcher and R. L. Fisher. Pp. v+18. (Washington, D.C.: Government Printing Office, 1951.) [1411

Conseil scientifique pour l'Afrique au Sud du Sahara (Scientific Council for Africa South of the Sahara). Publication No. 1: Brochure. Pp. 12. (Kikuyu, Kenya: Scientific Council for Africa South of the Sahara, 1951.) [1411

United States Department of Agriculture. Circular No. 878: Pests of Sugarcane and their Control. By J. W. Ingram, E. K. Bynum, Ralph Mathes, W. E. Haley and L. J. Charpentier. Pp. 38. 15 cents. Leaflet No. 309: Preventing Greenbug Outbreaks. By R. G. Dahms. Pp. 8. 10 cents. Technical Bulletin No. 1034: Effect on Truck Crops of DDT applied to the Foliage. By C. A. Weigel, A. C. Foster and R. H. Carter. Pp. 20. 10 cents. (Washington, D.C.: Government Printing Office, 1951.) [1411

Bulletin of the American Museum of Natural History. Vol. 97, Article 4: Results of the Archbold Expeditions, No. 65, The Rodents of Australia and New Guinea. By G. H. H. Tate. Pp. 183–430. (New York: American Museum of Natural History, 1951.) 5 dollars. [1411

Transactions of the American Philosophical Society. New Series, Vol. 41, Part 3: The History of American Ornithology before Audubon. By Elsa Guerdrum Allen. Pp. 385–591. (Philadelphia: American Philosophical Society, 1951.) 2 dollars. [1411

Académie Royale de Belgique, Classe des Sciences. Mémoires, Tome 26, Fascicule 3: Théorie de la représentation linéaire des groupes alternés. Par Dr. H. G. Garnir. Pp. 22. (Bruxelles: Académie Royale de Belgique, 1951.) 25 francs. [1511

Fieldiana. Zoology, Vol. 31, No. 54: The Baculum of the Gorilla. By D. Dwight Davis. Pp. 645–648. (Chicago: Chicago Natural History Museum, 1951.) 10 cents. [1511

Research and the Wool Industry: some Recent Developments. Pp. 17. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1951.) Free. [2111

Ceylon. Sessional Paper 24, 1951: Report on a Survey of the Inland Fisheries of Ceylon. Pp. 16. 40 cents. Part 4: Education, Science and Art (L). Administration Report of the Acting Director of Fisheries for the Years 1940 to 1950, Part 1, 1940 to 1947. By E. R. A. De Zylva. Pp. L.20. 40 cents. (Colombo: Government Publications Bureau, 1951.) [2111

Journal of Scientific Research of the Benares Hindu University. Vol. 1, 1950–51. Pp. v+177. (Benares: Benares Hindu University, 1951.) [2111

Australian National Antarctic Research Expedition. Reports, Series D: Meteorology. Vol. 1: Heard and Macquarie Islands, 1948. By W. J. Gibbs, A. V. Gotley and A. R. Martin. Part 1 (b): Analysed Charts. Pp. v+61 charts. (Melbourne: Department of External Affairs, 1951.) [2111

Department of Agriculture, Ceylon. Peradeniya Manual No. 7: A Manual on the Weeds of the Major Crops of Ceylon. Prepared by a Committee consisting of Dr. J. C. Haigh and representatives of the Tea, Rubber and Coconut Research Institutes. Pp. iii+50+vi+50 plates. (Colombo: Ceylon Government Press, 1951.) 5 rupees. [2611

United States Department of Agriculture. Farmers' Bulletin No. 1780: How to Fight the Chinch Bug. By C. M. Packard, Philip Luginbill, Sr., and Curtis Benton. Pp. ii+21. (Washington, D.C.: Government Printing Office, 1951.) 15 cents. [2611

World Health Organization. Technical Report Series No. 44: Joint FAO/WHO Expert Committee on Nutrition; Report on the Second Session. Pp. 64. 3*s*.; 40 cents; 1.60 Swiss francs. Technical Report Series No. 45: Prevention and Treatment of Severe Malnutrition in Times of Disaster. Pp. 56. 2*s*. 9*d*.; 35 cents; 1.40 Swiss francs. (Geneva: World Health Organization; London: H.M. Stationery Office, 1951.) [2711

Marcel Proust et la météorologie. Par Louis Dufour. Pp. 6. (Bruxelles: Revue de l'Université de Bruxelles, 1951.) [2711

Sudan Government: Wellcome Chemical Laboratories. Report of the Government Analyst for the Period 1.1.1950–30.6.1951. Pp. 14. (Khartoum: Wellcome Chemical Laboratories, 1951.) [2711

State of California: Department of Natural Resources. Forty-first Biennial Report of the Division of Fish and Game for the Years 1948–1950. Pp. 143. (Sacramento: California State Printing Office, 1951.) [2711